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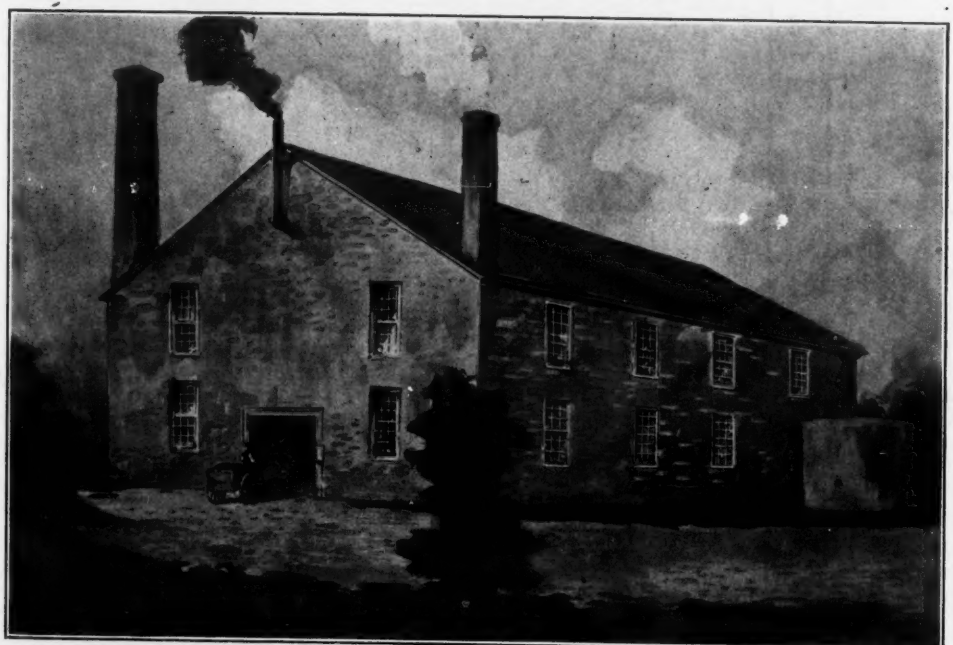


From a drawing by Frank H. Taylor

PLANT OF JOHN HARRISON, FIRST AMERICAN MANUFACTURER OF SULFURIC ACID

EDITOR'S OUTLOOK

The Frontispiece

"NO OTHER fluid, excepting water," to quote the *Dupont Magazine*, "is so universally used in the chemical industry as sulfuric acid, the king of chemicals. It transcends all others in importance and is the vital fluid of the nation's industries. For chemistry touches every industry in one way or another, and sulfuric acid is as indispensable to chemistry as iron is to metallurgy.

"The production and use of sulfuric acid has possibly contributed quite as much to our national wealth as have iron and steel. Indeed, one authority states that 'the civilization of a country may roughly be gauged by the amount of sulfuric acid made in it.' "

This month's frontispiece is a scene from the early history of the sulfuric acid industry in America. John Harrison, a pupil of Priestley established the first plant at Philadelphia in 1793. It was a very modest beginning, for he produced there only about a carboy of acid a day, or in the neighborhood of twenty tons a year.

In 1807 a much larger chamber was constructed, but within two years it was destroyed by fire and was replaced by the building pictured on the opposite page. This plant consumed about a ton of Sicilian sulfur a day.

Here the old and expensive process of concentrating sulfuric acid in glass vessels was abandoned and a platinum still of twenty-five gallons' capacity—the first in America—was installed. This continued in use for about fifteen years.

The sulfuric acid plant was but one of Harrison's chemical enterprises. In recognition of his accomplishments in the founding of the paint and chemical industries in this country, one of the laboratories at the University of Pennsylvania bears his name.

We wish here to express our appreciation of the kindness of Dr. E. R. Manchester and the *Dupont Magazine* in permitting us to reproduce this picture and in furnishing us the historical sketch briefly outlined above.

Summer Courses

PROBABLY all teachers who are contemplating attending summer sessions and who have not already formulated definite plans are now doing so. Hence Miss Hayden's "Survey of Courses in the Teaching of Chemistry,"[1] including, as it does, summer as well as winter courses, makes a very timely appearance.

Among the many excellent courses listed in this article and in our news and advertising columns, it might seem an invidious

[1] See p. 528.

distinction to single out any one for commendation. The series of special lectures to be offered at Columbia this summer[2] is, however, so unique and embodies so excellent an idea that we feel constrained to direct attention to it. Seldom, we venture to assert, has such a distinguished array of recognized chemical authorities been assembled for the presentation of a single course.

To the specialist who desires to learn something of fields other than his own and to the general chemist who desires a survey of the present status of many widely varying fields, these lectures should prove equally attractive. The teacher of chemistry, in whichever of these categories he may belong, will find them almost ideal.

The fortunate group which attends the course, no less than those unable to do so, will welcome the news that the lectures are to be ultimately collected and issued in permanent form.

Two Points of View

IT IS seldom that we employ the editorial privilege of unrestricted comment to take issue with a contributor upon a question of opinion. When, however, Dr. Rich, in a footnote to his article,[3] avows "strong personal convictions that any such requirement as English composition. . . . . in chemistry examinations is entirely illegitimate, as well as directly harmful in preventing chemical instruction from being directed towards its greatest usefulness to the pupils," we trust that it may not be taken amiss if we venture to point out that a different and not wholly untenable point of view is possible.

We agree with what we believe to be Dr. Rich's contention that chemical knowledge and facility of expression are independent of each other and that an attempt to measure the one should not be confused by conscious or unconscious recognition of the other. If it be conceded that the proper function of a chemistry examination is that of a psychological experiment designed to scientifically determine chemical knowledge and that alone, he is unquestionably correct. We hesitate, however, to make this concession.

It appears to us not unreasonable to demand that chemical instruction shall, in addition to imparting chemical knowledge, develop in the pupil in so far as may be possible the ability to put that knowledge to use in after life. Not the least of the factors which contribute to the value and utility of knowledge is the ability to transmit that knowledge, and the ideas which evolve from it, to others—that is, to express oneself clearly and in language appropriate to the subject under discussion.

[2] See page 606.

[3] See page 527.

We have no desire to saddle upon the instructor in chemistry those duties which properly belong to his colleague in the English department. We do contend, nevertheless, that if he fails to supplement the work of the English instructor by acquainting his pupils with the terminology and the accepted usages of his specific science, and holds himself so strictly to attending his own business that he neglects to frown upon such illiterate crudities as are everywhere offensive among the educated, he has fallen considerably short of a commendable discharge of his responsibilities.

With this preliminary explanation accomplished we can proceed to state our thesis in a few simple propositions. The aim of chemical instruction as we conceive it is, briefly, to enable the pupil to make use of chemistry in after life. The ability to speak and write intelligibly of chemistry and the things pertaining to it will play an appreciable part in the utility of chemical knowledge. If, as we believe, the chemistry examination should evaluate the results of chemical instruction, it may legitimately take cognizance of all factors which influence the effectiveness of that instruction.

Nothing but a faint suspicion of our own fallibility persuades us against appending the appropriate Q. E. D.

A Constructive Educational Work

IT APPEARS to us that so excellent an extra-scholastic educational activity as that which has been carried on by the Indiana Section of the American Chemical Society for the past four years is worthy of more than casual attention from other similar organizations and should be of interest to all engaged in the promotion of chemical education. The most recent of the "Biennial Student Meetings" to which we refer is reported in this number of the JOURNAL by Robert M. Lingle under the title, "Is a Meeting of College Chemistry Students Worthwhile?"[4] and a brief account of the idea and the details of its operation is given.

That the inspection trips and lectures which constitute the principal features of these meetings are enthusiastically received both by the students and their instructors is evidenced by the fact that this year's registrations totaled three hundred. No one who has enjoyed the privilege of attending a Student Meeting can fail to be impressed with the splendid coöperative spirit with which the Indiana Section has entered into the planning and rendering of this and other services to the advancement of chemical education.

The members of the Section are well pleased with the response which

[4] See page 576.

their efforts have met and point with pardonable pride to the fact that Indiana college students have won three of the twelve national prize essay awards offered by the American Chemical Society in the past two years. They are inclined to believe that coincidence has not been entirely responsible for this excellent showing and we would scarcely undertake to contend that their belief is without reasonable foundation.

So far as our information extends, no other local section is at present conducting a similar program. It is to be hoped, however, that a number of others, particularly those favorably located in industrial areas, may see their way clear to undertake projects of this nature.

A Beloved Professor

THERE is probably no teacher of chemistry in American who is more widely known or more affectionately regarded than Dr. Edgar F. Smith. Those who have made his acquaintance and have learned to respect and admire him only through his contributions to chemical science, his text-books and his delightful biographical essays on historical chemists may catch some hint of his personal charm in Miss Jacobs' account of "A Visit to Edgar Fahs Smiths."[5] His former pupils and his many friends in the profession will enjoy this description of familiar scenes and recognize with pleasure the characteristic discourse of an old friend.

We join with Miss Jacobs in expressing the sincerest appreciation of the kindness of Mr. William Rogers in furnishing the pictures which accompany the text.

This month Dr. Smith celebrates his seventieth birthday. We hope that we shall for many years have occasion to repeat the greetings and kind wishes which we now extend to him.

[5] See page 500.

JOHN DALTON

ARTHUR HOPWOOD, CHEMISTRY AND TECHNICAL SCHOOL, CARLISLE, ENGLAND

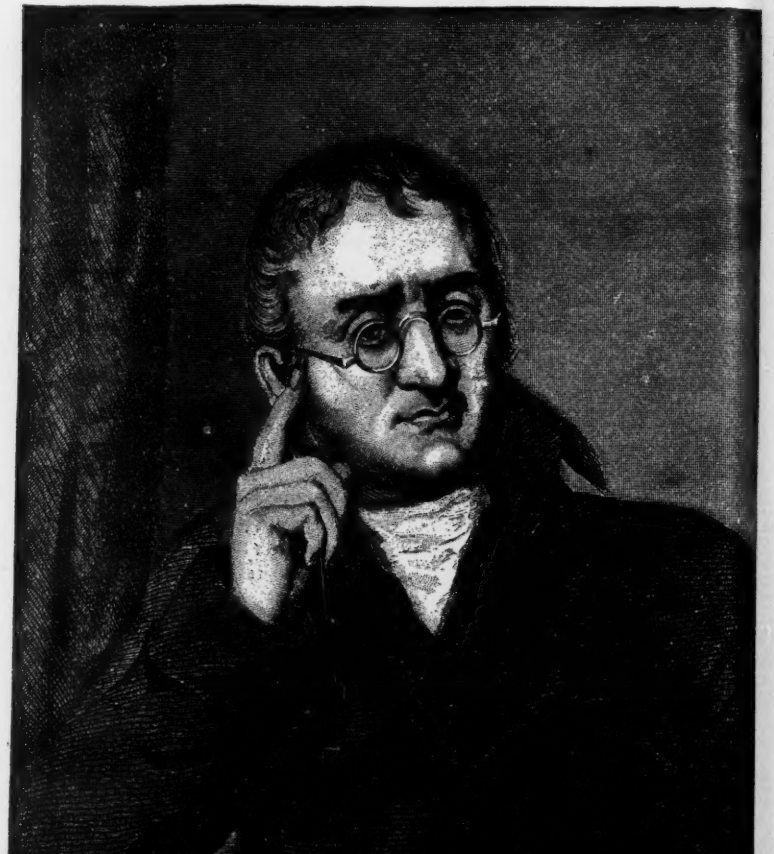
John Dalton, the founder of the chemical atomic theory of the constitution of matter, was born about the 5th of September, 1766, in the village of Eaglesfield, near Cockermouth, in Cumberland. He was the son of a poor hand-loom weaver, and always lived in relatively humble circumstances. Throughout his life he was solely dependent on his own exertions, yet he rose to be one of the most famous of men. His career illustrates in a remarkable manner the fact that independence of character may lead a powerful mind to conclusions of the greatest importance, notwithstanding deficiencies resulting from imperfect education and rural environment.

His parents, Joseph and Deborah Dalton, came of an old Cumbrian Quaker stock, and had altogether six children. Three of these children, Jonathan, John, and Mary lived to a good old age, three others died early. John, like his brothers and sisters, was brought up in the necessarily hard conditions of life imposed by the poverty of the family, and to a large extent was self-taught. He had the good fortune, however, to be sent to the village school at Eaglesfield carried on by Mr. Fletcher, a Cumbrian Quaker schoolmaster of much ability, and attended there "till eleven years of age, at which period he had gone through a course of mensuration, surveying, navigation, etc." Dalton in his early years not only attracted the attention of his Quaker schoolmaster, but also that of another remarkable Eaglesfield man, Mr. Elihu Robinson, who became his patron and then his fast friend for life. Mr. Elihu Robinson was a capable meteorologist and also a skilled instrument maker, and young Dalton was particularly fortunate to have so good a coach in those days to assist him in his studies.

The progress which young Dalton made under these stimulating influences was very great, for, in his own words, he "began about twelve to teach the village school, and continued it two years." As the emoluments coming to the "head" of the school were not large, young Dalton had to increase his earnings by working as a laborer on a small patch of land which his father farmed.

When Dalton was fifteen, in 1781, he left Eaglesfield to become an assistant in a school for "Friends" of both sexes at Kendal, where he "remained in that capacity for three or four years, then undertook the same school as principal and continued it for eight years."

During the twelve years that John Dalton kept school at Kendal he was unceasingly engaged in self-improvement. He contributed frequently to a semi-educational periodical entitled the *Ladies' and Gentlemen's Diary and Woman's Almanac*, edited by Dr. C. Hutton of the Royal Military Academy, and on more than one occasion received a prize for the solution of problems in mathematics and philosophy.



JOHN DALTON

In Kendal, as at Eaglesfield, Dalton was singularly fortunate in securing the friendship of persons of similar tastes and character. In this instance it was to a blind man (Mr. John Gough) that young Dalton was indebted for a close and valuable friendship. Gough had unfortunately been rendered quite blind by smallpox when about two years old, but in spite of this drawback he was a most competent scholar and investigator. Dalton often gratefully recognized his indebtedness to Gough for the assistance the latter gave him in his studies and investigations.

Following the lead of Elihu Robinson in Eaglesfield, and of John Gough in Kendal, Dalton's first attempts of scientific investigation were daily observations of temperature, barometric pressure, rainfall, dew point, and other meteorological subjects with his home-made instruments. From these early days to the day before his death Dalton continued to make daily observations on the weather, the number of observations which he made and registered during his long life amounting to 200,000. We gain a clue to his motive in these studies from a letter written in his twenty-second year, in which he speaks of "the advantages that might accrue to the husbandman, the mariner, and to mankind in general if we were able to predict the state of the weather with tolerable precision."

In 1787 Dalton tried his hand at public lecturing, as in October of that year he began a course of twelve lectures on natural philosophy at the School in Kendal. In the subsequent years of his life, Dalton repeated his public lectures both in Kendal and elsewhere, but, as would appear, with scanty success, as he was never a really popular exponent of science even in after years when in the height of his fame.

In 1793 Dalton left Kendal and henceforward took up his permanent residence in Manchester, where he had obtained the post of tutor in mathematics and natural philosophy at the New College, an institution which had been established in 1786 by the Presbyterians of Manchester. In Manchester, Dalton soon found a much wider sphere for his great powers than in Kendal, and judging by his letters to his old friends in the North he seems to have been very happy in his new post. He soon found, however, that his time was so much taken up with tuition at the College and with private tuition at home that he had scarcely time to turn to any mathematical or philosophical pursuit. And so as time went on he began to consider the advantages to his freedom which would result from his giving up the tutorship at the College and gaining his living as a private tutor. Accordingly in 1799 he resigned his tutorship at the College, and henceforward devoted his life to scientific inquiry, but earning his bread as a private teacher, principally in mathematics and natural philosophy, to such as might come to him at a charge of two shillings a lesson.

When he arrived in Manchester from Kendal, Dalton brought with him the manuscript of a volume entitled "Meteorological Observations

and Essays," and this was printed and published in 1793, and appeared in a second and enlarged edition forty-one years later. These observations were made and the book written at Kendal. The work begins with descriptions of the barometer, thermometer, hygrometer, and rain gauges, and connected with these are tables of observations made at Kendal and Keswick. The book also contains essays on the barometer, on the thermometer and their variations, on the formation of cloud, on evaporation, on the distribution and character of atmospheric moisture, and on the aurora borealis, which if they had been written at the present day might well be considered as remarkable productions from the pen of a well-trained and experienced philosopher. How much more remarkable must they appear when we remember that they were written at the end of the seventeenth century by a young Kendal schoolmaster ignorant, to a great extent, of what had been written by others, and out of reach of libraries and of books of reference.

On October 3, 1794, Dalton was elected a member of the Literary and Philosophical Society of Manchester. In May, 1800, he was elected Secretary of the Society, which office he held until 1808, when he was made a Vice President. In 1817, he was raised to the dignity of the Presidential Chair, and continued in this high office for the rest of his life. During his long connection with the Society he contributed to it 116 memoirs and essays on various subjects, the more important of which were his first communication read on October 31, 1794, dealing with the "Color Blindness" of himself and his brother, and his communication read on October 21, 1803, introducing his "Chemical Atomic Theory" and his "First Table of the Relative Weights of the Ultimate Particles of Bodies."

The ancient Greek philosophers had long ago taught that matter is made up of small indivisible particles, and the idea of the atomic constitution of matter, and even the belief that chemical combination consists in the approximation of unlike particles, had been already expressed by Kirwan in 1783, as well as by Higgins in 1789. Dalton was, however, the first to propound a truly *chemical atomic theory*, the only one hitherto proposed which explains the facts of chemical combination in a satisfactory manner. The cardinal point upon which Dalton's atomic theory rests, and in which it differs from all previous suggestions, is that it is a *quantitative* theory respecting the constitution of matter, whereas all others are simply *qualitative* views. For while all previous upholders of an atomic theory, including even William Higgins, had supposed that the relative weights of the atoms of the various elements are the same, Dalton at once declared that *the atoms of the different elements are not of the same weight; and that the relative atomic weights of the elements are the proportions by weight in which the elements combine or simple multiples or sub-multiples of them.*

"The atomic theory," writes Sir William A. Tilden in 1921, "has undergone modification in every direction since Dalton's day. But to the original conception we owe to a large extent the development of chemistry as a department of science. Without it chemistry would have continued to consist of a mass of heterogeneous observations and recipes for performing experiments or for manufacturing metals, salts and all kinds of compounds, but without the law and order by which the whole becomes intelligible."

Dalton was never a good popular lecturer on scientific subjects, but the originality of his ideas, and the importance of the facts which he had discovered, placed him in the forefront of the scientific men of the age, so that we need not wonder to find that the Royal Institution in London wanted Dalton to give a course of lectures; and he first appeared before that critical audience on December 22, 1803, lecturing not merely on chemistry, but on mechanics and physics, repeating the course again in the winter 1809–10.

In 1807 Dalton gave a similar course of lectures, to those he had given in London, both in Edinburgh and in Glasgow.

It was not until about the year 1815 that Dalton came to be known as a man of mark in the scientific world, or rather it was not until then that his merits were fully appreciated by those who were in authority at that time. One of the first marks of this appreciation was the offer to Dalton in 1818 of the post of scientific expert to the expedition which the Government was about to dispatch to the Polar regions under the command of Sir John Ross, but Dalton characteristically refused the offer, preferring to stay at home and carry on his researches in his laboratory rather than to voyage in the cold Polar Seas.

Honors first came to Dalton from abroad. In 1816 he received the first mark of distinction when he was elected a corresponding member of the French Academy of Sciences, and this honor he prized highly.

In 1822 Dalton visited Paris and made the personal acquaintance of the leading French scientists of that time. He attended a meeting of the Academy of Sciences, and also visited the laboratories of some of the great French savants.

In 1810 Sir Humphrey Davy proposed to Dalton to offer himself as candidate for election to the Royal Society, London, but for some unknown reason Dalton refused to put in a nomination, and it was not until 1822 that Dalton was proposed (without his knowledge) and duly elected a Fellow of the foremost of English scientific societies.

In 1826 the Royal Society of London awarded the first of the Royal Medals given by the King (William IV) to Dalton "for the development of the chemical theory of definite proportions, usually called the Atomic Theory, and for his various other labors and discoveries in physical and

chemical science." This afforded to Sir Humphrey Davy, as President of the Society, the opportunity of testifying to the high position held by Dalton in the esteem of the world of science.

Honors both from his own country and from abroad, poured in upon Dalton in later life. Davy's death had caused a vacancy among the seats of the eight foreign associates of the French Academy, and to this—one of the highest honors which a man of science can receive—John Dalton was elected in 1830. Other foreign academies—notably those of Berlin, Moscow, and Munich—placed his name on their roll of foreign members.

The Statue of Dr. Dalton by Chantrey.

Dalton was one of the founders of the British Association for the Advancement of Science, and he took part in the early meetings of the Association at York (1831), Oxford (1832), and Cambridge (1833). At the Oxford gathering, in 1832, the degree of D.C.L., was conferred upon him. Probably that ancient university never distributed its honors to four more distinguished men than on that occasion. They were John Dalton, Michael Faraday, David Brewster, and Robert Brown. Dalton evidently seemed proud of his scarlet gown; nor did this color strike him as anything out of keeping with his Quaker habit, for to him both that and the green of the Oxford gardens appeared as a dull drab.

In 1833 Lord Grey's Government granted Dalton a pension of £150 a year and this was increased to £300 a year in 1836. The announcement of the first grant was communicated to Dalton by Professor Sedgwick, the eminent geologist in his address as President of the British Association for the Advancement of Science delivered in the Senate House of the University of Cambridge, the announcement being received, by the members present, with prolonged applause.

While the Government and the nation were thus testifying to the value of Dalton's work, Manchester was not unmindful that she had a prophet within her walls, and his friends and admirers far and wide were induced to take steps to secure a suitable and lasting memorial of the great citizen in the town where he had so long labored. The question as to whether this should take the shape of a building devoted to scientific research, or of a more personal memorial such as a statue, was at length decided in favor of the second alternative. In 1834, Dalton therefore sat to Chantrey, the sculptor, in London, for the statue destined to stand in the grand entrance of Manchester Town Hall, and opposite to it is the fine statue of James Prescott Joule, Dalton's greatest pupil and follower. Thus is Dalton's memory kept green amongst the citizens of Manchester.

In 1834 Jonathan Dalton died, and the manner of his decline from paralysis seemed to foreshadow the end of his distinguished brother, for both survived the first seizure several years. The first attack, in the case of John Dalton, occurred in April, 1837. From this he partly recovered but on July 27, 1844, the malady recurred and was followed by a peaceful death a few hours later.

The feeling in Manchester on the death of Dalton was so deep that a public funeral was decided upon. His remains were placed in the darkened Town Hall, and they were visited by no less than 40,000 persons. On August 12th the funeral took place. A procession of more than one hundred carriages accompanied the body to the Ardwick Cemetery, and many hundreds of persons went on foot to the grave. All the shops and warehouses on the route, and many others, were closed. And thus the body of the simple-minded "Friend" was brought to mother earth.

But Manchester did more than this to honor Dalton. On January 26, 1853, a towns-meeting was held for the purpose of founding a scholarship for the encouragement of original research in chemistry, to be held in the then newly established Owens College, now the headquarters of Manchester University. A sum of £4000 was raised by public subscription, and a more fitting testimonial could not have been proposed. The establishment of a scholarship for scientific research was at that time a circumstance without a parallel; but, in spite of the novelty of the experiment, the experience of seventy years has fully borne out the wisdom of the course which its originators adopted, and today there exists a long list of "Dalton Scholars" who have contributed to the progress of chemical science, many of whom hold high and responsible positions in scientific, manufacturing, and official life.

THE STORY OF BAKING POWDER

P. F. ZIEGLER, CALUMET BAKING POWDER CO., CHICAGO, ILLINOIS

Baking powder became a commercial article about 1870. Prior to that time, this product, which has now become a necessity in the household, was not known. Doubtless many readers look back to the times when the lords and ladies lived in their castles surrounded by knights and yeomen, with a feeling of envy. But how many of them would be satisfied with the simple daily fare that was served at the tables of those castles, if they really understood how lacking in variety such fare was as compared with that enjoyed by the common citizen of the United States today? Broiled and sodden foods were most prevalent. Breads were far from the appetizing morsels of today. Cakes and pastries were rare, used only on special occasions, and there was very little variety of them. One of the disadvantages of those times was the lack of the modern equipment which we now enjoy. The iron stove and the steel oven are the products of a recent day. Then the leavening of the cakes was effected laboriously by hand-whipping of eggs, and the production of gas in the cake mix was unknown.

Later the use of sour milk and soda as a leaven was discovered. Sour milk contains lactic acid and when this reacts with sodium bicarbonate, carbon dioxide gas is produced. This was an improvement and the forerunner of modern baking powders. Cakes at once became more common in the household and the use of soda and sour milk persists to a very small extent even to the present day. Failures, however, are common when these two substances are mixed together, due to the fact that the proper proportion of soda and milk is seldom used, and as a consequence the biscuits are often yellow and are alkaline in taste.

Then baking powder was discovered. In this the amount of acid and soda are properly proportioned so that both are neutralized during the process of baking. The acid of baking powder must be a dry acid, of course. There are many such acids, most of them organic substances. Citric acid, the principal acid contained in lemons, is one. Tartaric acid is another. Besides the true acids, the acid salts are also available. Of these calcium acid phosphate, commonly called acid phosphate, and potassium acid tartrate (cream of tartar) have found a wide use in baking powder manufacture. In 1864 Professor Horsford, of Cambridge, patented a baking powder in which he used acid phosphate. He succeeded in interesting Liebig, his former teacher, in his new product and the latter introduced and manufactured it in Germany. Cream of tartar baking powder was originated about 1868. Then came the third type of dry acid ingredient comprising the salts that act as very weak acids even though they have no replaceable hydrogen. Sodium aluminum sulfate today is the sole surviving member of this group.[1]

[1] For a short time around 1880, according to Hart in his book, "Leavening Agents,"

Any of these three kinds of substances, the acid, the acid salt, or the salt with acid properties, acts upon soda and sets free carbon dioxide gas. The action takes place almost as quickly as the acid or salt dissolves. In the case of cream of tartar, acid phosphate and tartaric acid, the action is immediate, while sodium aluminum sulfate requires heat for the action because it is very slowly soluble in cold water. The active principals of baking powders are soda and one or more of these four substances.

We obtain these acid ingredients from quite varied sources. Cream of tartar and tartaric acid are both manufactured from argol, which is the sediment that separates out at the bottom of the wine vat during fermentation. Calcium acid phosphate is now manufactured to a very large extent from phosphate rock, the more recent process having supplanted the manufacture from bone black. Sodium aluminum sulfate, known to the trade as S. A. S., is made from sodium sulfate and aluminum sulfate by mixing solutions of the two salts together, concentrating and subsequently roasting.

There are a great many different kinds of carbonates all of which will give carbon dioxide gas when added to an acid. However, sodium bicarbonate is the one used almost exclusively in the manufacture of baking powder. It is commonly known as saleratus, or baking soda, and on the baking powder label is always named soda. It is sometimes referred to as the alkali of baking powder. It is a white crystalline substance of very high purity, being as free from impurities as the granulated sugar used on the table. It is manufactured from common salt through the action of acid ammonium carbonate. Soda, when heated, readily gives off carbon dioxide gas, and hence may be, and often is used in cooking without the addition of any other substance for the purpose of leavening. It, however, only loses one-half of its gas when heated and leaves the strongly alkaline normal carbonate in the food.

Sodium bicarbonate (magnified).

Besides the acid and alkali, all baking powder contains starch. This is

alum was used in baking powder as an acid ingredient, but its use has been entirely abandoned. Today the calcined, water-free material, sodium aluminum sulfate, is the only aluminum compound used in baking powder.

corn starch of the highest grade and purity and is specially prepared for food purposes. The starch serves several purposes. It mechanically separates the soda from the acid or acid acting salt, and prevents direct contact between these active ingredients. This lessens the probability of interaction in the can should moisture be absorbed. Starch absorbs more moisture than any of the other ingredients and for that reason helps to keep moisture from the acid and alkali. If starch were left out of baking powder, the resulting mixture would be far too strong to handle efficiently, so that it serves still another purpose in reducing the strength of the powder to a point where it can be used efficiently with the ordinary household methods of measurement. The lower limit of the amount of available gas in baking powders is regulated by a federal standard which requires a baking powder to produce at least 12 per cent of its weight of carbon dioxide. The best powders on the market today produce between 14 and 15 per cent.

As has been mentioned before, the acid phosphate and cream of tartar baking powders are very quick-acting and liberate their gas in the cold. With these powders great care is necessary to get the best and sure results. This care is necessary because this type of baking powder gives off practically all of its gas in the cold mix. To illustrate better what happens let us take, for an example, the actual baking of a cake with this powder. By the time the cake batter has been mixed and is ready for the oven, the action of the powder is practically finished. The dough mass is fully distended and the carbon dioxide gas held prisoner inside. As soon as the dough is put into the oven the gas begins to expand. If the temperature of the oven is right the cake will set before the gas has a chance to break through and escape. This correct temperature is a high one and consequently great care must be taken to avoid burning the cake. In avoiding the burning hazard, however, oft-times the oven is allowed to become too cool; then the gas escapes while the cake is still in a doughy condition and the mix falls and bakes flat. For best results with powders of this type, the dough must set quickly in a quick oven.

Having in mind the disadvantages of the quick-acting powders, manufacturers set about to find an acid ingredient that would act more slowly with soda. Such an ingredient was found in sodium aluminum sulfate, which appeared on the market about 1889. This substance reacts with soda very slightly in the cold, because it dissolves so slowly in cold water when compared to acid phosphate or cream of tartar. Heat, however, accelerates the reaction. With the introduction of the straight sodium aluminum sulfate powder, the pendulum swung from the quick acting powders to one that needed the oven temperature before its action started. This new powder developed obvious disadvantages in a practical way also. These can again best be brought out by describing another cake baking.

If such a cake is baked in a slow oven, the heat penetrates the whole mass and the baking powder liberates its gas before the cake is finally crusted by the cooking. A slow oven gives the best results with this type of powder, though there is the danger of having the oven too low and not thoroughly cooking the inside of the cake. On the other hand, too hot an oven causes the cake to crust over before the heat has penetrated sufficiently to cause the baking powder to react and results in a flat or misshaped cake.

From these facts it is seen that the speed with which baking powder gives off its gas has a very important bearing on the temperature at which the food should be cooked. A baking powder that would give its best results in a medium oven was obviously desirable. It is not surprising then that the next step forward should be the advent of the combination powder, one that does not require a critical temperature adjustment. Two acid ingredients were used in this mixture, a quick-acting substance such as calcium acid phosphate and the slower acting sodium aluminum sulfate. Here was a powder that required a medium oven. There was far less chance to spoil the baking made with this powder because the oven temperature could now safely vary within much wider limits. If a cake mix is prepared with this powder, when the dough is ready for the oven, it is partly distended by the quick-acting portions of the powder and this partial leavening is supplemented in the oven by the remaining slower acting part. There is no danger here that the gas will all escape before the cake is set or that the dough would set before leavened by the gas. The safety zone for a good cake is much wider with the combination powder than is the case in either of the two other types. There is far less likelihood of the cake burning or of any part of it remaining in an uncooked condition. It is the mean between two extremes and today the mixed or combination powders dominate the field. Government estimates state that over 200,000,000 pounds of baking powder are used annually. Of this amount about 75 per cent is of the phosphate–S. A. S. type.

A further improvement in baking powders was one that enabled manufacturers to test their distributed stock and replace any goods that had deteriorated—thus always insuring the customer a fresh product. This method of testing was made available when a small quantity of dried white of eggs was added to baking powder. The egg white dissolves easily in cold water and the viscous nature of the solution holds the bubbles of gas as they are set free from the baking powder. By knowing how high the encased bubbles from fresh stock rise when a definite quantity of a baking powder is put into a glass with some water, it is an easy matter to detect a deteriorated powder of the same make by noting the difference in the height it rises. The better manufacturers today test the dealers' stocks regularly and replace decomposed powder with fresh stock.

There is a general impression that the proper manufacture of baking powder consists of merely weighing out and mixing the different ingredients. This opinion is shared even by some of the poorly informed and less progressive manufacturers of the product. It is, however, far from the truth. The up-to-date manufacture of baking powder requires the greatest care and most thorough chemical supervision. A perfect baking powder cannot be made by one who relies upon the manufacturer of the ingredients to always furnish him goods of the same purity, the same dryness, or the same strength.

A knowledge of chemical action shows that where a certain weight of soda is used, a fixed amount of the chemically pure acid ingredient is necessary to set free all the gas. As a matter of fact these acid ingredients as manufactured for baking powders, while of the highest grade of purity from a food standpoint, vary somewhat in their strength. Consequently, the baking powder manufacturer in addition to analyzing these substances for harmful impurities, must also determine their actual strength. This latter knowledge will enable him to add the right amount of each in his mixture so that neither acid nor alkali is left when the baking powder has reacted. Only by knowing the exact strength of the different ingredients can the mix be thus perfectly proportioned and the powder be kept absolutely uniform from day to day. For this work a well-equipped laboratory is essential.

Dried white of egg (magnified).

It is because these quantitative relations between the amount of soda and the amount of acid substances used must exist for the production of a proper and perfect baking powder, that the custom of mixing soda and cream of tartar still used in many homes is so objectionable. It is safe to say that the proper proportions are never obtained in the home except by accident, and not more than once in a thousand times. A good baking powder is, therefore, from this consideration alone, much to be preferred to such a mixture. It is also customary in some homes to use soda and sour milk in place of baking powder. Here again the proper proportion is impossible. In general, too much soda is used, as the milk ordinarily

contains insufficient lactic acid to destroy the soda and set free the carbon dioxide gas.

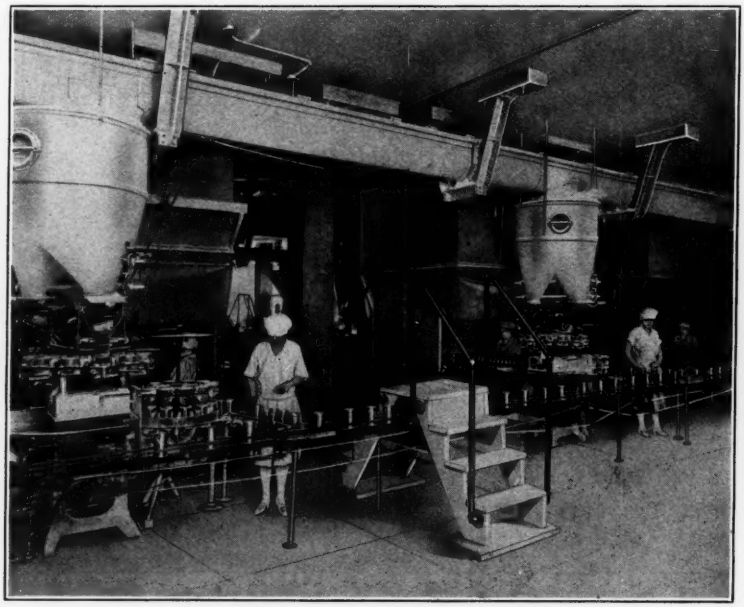
Besides the analysis for strength and purity, the manufacturer must also take every precaution, by analysis, to determine that the ingredients are of the proper dryness. This is particularly true with reference to the starch used, as starch rapidly absorbs moisture. Starch as purchased by the housewife contains from 10 to 13 per cent moisture, whereas the better baking powder manufacturers use starch that contains less than 5 per cent. To introduce wet starch into the manufacture of baking powder

Complete chemical control is necessary in making baking powder.

would have the same effect as to pour water upon the powder itself. The powder would be spoiled before reaching the consumer. This same precaution regarding moisture must be taken with reference to the other ingredients also, as these are sometimes shipped in rainy weather and in leaky cars.

Having analyzed all his ingredients for heavy metals and other objectionable impurities, determined their strengths and moisture content, the up-to-date manufacturer goes even farther in insuring the consumer a perfect powder. Each batch of finished powder that comes from his mixers is analyzed. Thus a check is kept on possible errors in the mixing of the various ingredients. Then as a final proof that the baking powder is ready for use, an actual baking test is made in the experimental bakery.

The manufacturing appliances in use vary according to the size of the plant and the progressiveness of the manufacturer. The object of these should be not only increased convenience, but above all, the highest order of sanitation. Baking powder is a food product and the progressive manufacturer treats it as such. He insists on the most modern sanitary buildings, free from dust, flooded with sunlight and fitted with the latest specially constructed machinery, so that none of the ingredients nor the powder itself ever comes in contact with the human hand. This perfect protection should be demanded in every food product.

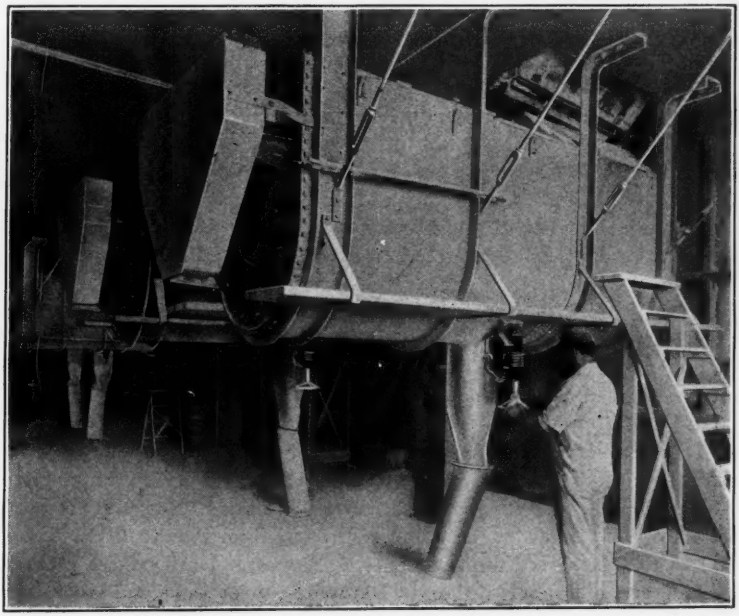


Automatic machines for weighing, filling, and conveying.

The machinery in such a building consists of tightly enclosed mixers, elevators, and conveyors so constructed that the powder is completely protected from moisture and contamination. Large, almost airtight bins are used for temporary storage of the ingredients, which empty directly into special containers standing on modern, accurate scales. A single container is used for each ingredient and no other substance ever enters it. These are emptied by gravity into the mixers through fine screens, so that any lumps are removed. These tightly closed mixers contain many flights of conveyors working in different directions, so that all the ingredients are perfectly mixed. From the mixer the powder passes by gravity into screw

conveyors, which carry it to the automatic filling and weighing machines (a further sanitary protection), where it is weighed into the can. There then remains the labeling of the cans and the boxing and packing to make it ready for shipment. The modern manufacturer of baking powder pays strict attention to the health and hygiene of his employees. They are clothed in white uniforms and required to keep scrupulously clean.

And so the little can of baking powder, whether it be on the shelf of the village grocer in some country hamlet or in the decorated window of a big city store, has quite a pedigree behind it. It stands ready to live up to



Baking powder mixers in a modern plant.

the heritage given it by trained chemical hands along the entire route of its manufacture—but like most of its neighbors on the same shelves or in the same window, it never gets a chance to tell the personal side of its romantic life. To the consumer it is just a can of baking powder.

Music is art, painting is art, poetry is art; but the greatest of all arts is that of taking plastic human nature and moulding it into something that would not have been had not your touched been added.—WILLIAM BISHOP OWEN

A VISIT TO EDGAR FAHS SMITH

ADELINE H. JACOBS, GERMANTOWN HIGH SCHOOL, PHILADELPHIA, PENNSYLVANIA

"Dr. Smith is engaged with a visitor at present, but he will be through shortly. Will you take a seat?" Miss R., the doctor's secretary, continued her reading while I glanced around the outer office where I waited. It proved a delightful ante-room, with its low bookcases and portraits relating to the history and development of the University of Pennsylvania and also of chemistry.

The two offices that have been used by Dr. Smith for many years are on the first floor in the southwest corner of the John Harrison Laboratory of Chemistry. They are particularly pleasing rooms, with potted plants in the windows. The woodwork and bookcases are painted white—of course, the kind of white paint used does not darken with stray hydrogen sulfide gas. The walls are a buff tint and the office furniture is suitable, but not elaborate.

A banker, holding the corresponding position in his world of finance that Dr. Smith holds in the scientific world, would doubtless indulge in Circassian walnut furnishings, elegant lighting fixtures, and tapestry panelled walls. Simplicity characterizes Dr. Smith. "Plain living but high thinking."

In fact little Mrs. Smith becomes quite distressed over the doctor's thoughtlessness regarding his wardrobe.

"I have to tell him when he needs a new coat. He would wear the same one until threadbare, and never know it."

Dr. Smith came to the University of Pennsylvania, as an instructor, in 1876 and continued in this capacity till 1881. Then he spent a few years away from the University. In 1888 he returned, having been appointed Professor of Chemistry. Besides being the Director of the John Harrison Laboratory of Chemistry, he was Vice-Provost from 1899 to 1911. From 1911 to 1920 he served the University as Provost. During these years of teaching and of administration, he has written text-books and laboratory manuals and has translated Richter's Inorganic and Organic Chemistries. He has published monographs on atomic weights including those of boron and of fluorine. In the field of electro-chemical analysis, he has also done pioneer work.

Always interested in the historical aspect of chemistry, particularly of American chemistry, he has gathered together many of his researches in this direction in a delightful book, "Chemistry in America."

Quite modestly does he bear his many degrees, and honorary memberships in learned societies. It is fitting that this man, now approaching his seventieth birthday, should be called the Dean of the American Chemical Historians.

It seemed that but a few minutes had passed, before Dr. Smith came to the

door and beckoned me into his inner office. After the usual exchange of greetings we were soon launched on the subject which Dr. Smith is pre-eminently qualified to discuss—the great chemists of all ages and countries, —"The Living Dead."

"Here they are," Dr. Smith said, as with a sweep of the hand he indicated the portraits forming a row on the walls of his office. "I am in the very best society here. When difficulties beset me, I raise my eyes, as I sit here, and I am heartened by their presence. There is Dalton who used the kitchen table and such utensils as were at hand for his experiments.

Meager equipment did not deter him from formulating the epoch-making atomic theory. And so each member of my row of notables has a silent message for me."

On the wall back of Dr. Smith's desk hangs a large etching, a reproduction of a painting, "The Arrest of Lavoisier." Lavoisier is seen standing by his flaming apparatus. With book in hand, he has been interrupted at his work by the noisy mob breaking into his laboratory. These common people crowd in at the open door, an enraged, gaping rabble at the heels of the gendarme. The latter, typifying the power of the government, displays the document for the arrest of Lavoisier.

"Yes," said Dr. Smith, "it was but a step from the laboratory to the gallows."

Too late the French government realized it should have guillotined the false phlogiston theory instead of its staunch opponent. Had the "Father of Modern Chemistry" been allowed to continue his brilliant investigations, what strides chemistry would have made during his life-time! How true is the statement that it took but a second to kill Lavoisier, but it required a century to produce his equal.

"When I get this far in talking to visitors about my collection of portraits, I can tell whether or not to continue. Not everybody is interested." He knew how I felt, so we moved over to the corner of his office devoted to Priestley. The uncongenial atmosphere of England drove Priestley from his home. However, in one of his letters he wrote: "I cannot refrain from repeating again that I leave my native country with real regrets."

So the discoverer of oxygen arrived in the United States in the spring of 1794. He was offered the Professorship of Chemistry at the University of Pennsylvania, but he declined this position. He preferred to lead a quiet life at Northumberland, Pa., one hundred and thirty miles northwest of Philadelphia, on the Susquehanna River. His oldest son with some other Englishmen had already settled there with the idea of establishing a colony for independent thinkers.

The frame house built for Joseph Priestley has assumed importance besides that shed on it by its illustrious owner. A picture of the Priestley house shows a small group of men on the porch. The photograph was taken in 1876 when a number of chemists made a pilgrimage to this chemical shrine. It was here, and on this occasion, that the idea was conceived of forming a national organization of chemists which has since grown into the American Chemical Society with its enormous enrolment of 12,000 members, and its splendid prestige.

Portraits and silhouettes of Priestley—doubtless copies of all that are in existence—have been gathered together here by Dr. Smith. A full length statuette of Priestley shows him garbed in the quaint costume of his times—the long tailed coat, narrow trousers, and lace ruffles at neck and wrists.

"This is Priestley's wife," Dr. Smith answered, as I paused before a portrait of a charming old lady with kerchief and poke-bonnet.

"There," said Dr. Smith, pointing to a glass case, "is one of the balances that Priestley used. I like to think that his hands have rested on it." A crude balance it is, to be sure, but all the gold its pans could weigh would not be enough to buy it from its present owner.

Opening a bookcase, Dr. Smith displayed a complete set of books written by Priestley. What a variety of subjects in the realms of theology, physics, mathematics, and chemistry engaged the pen of this versatile man! One title caught my eye, "Concerning the Jews."

"For or against?" I queried.

"Oh, for them," Dr. Smith replied. "Priestley was a very liberal man." Persecution and animosity! When will the dove of peace be bred by science?

"Now, Miss R.," said Dr. Smith as he stepped to the door between the

A corner of Dr. Smith's office.

two offices, "will you bring me the Priestley manuscript from the safe, please?"

Dr. Smith placed in my hands the actual pages which Priestley himself wrote, setting forth his experiments in heating "mercurious calcinatus" which led to his discovery of oxygen or dephogisticated air, as he termed it. The writing, though very regular, and of a remarkably clear black color, was a bit difficult to decipher. While I followed the manuscript, Dr. Smith, himself a distinguished chemist, read aloud the first paragraph from a corresponding typed page.

This seemed to me the pinnacle of inspiration. What could be more impressive? I had been lifted out of the world of the commonplace by this old teacher of my college days. I was thrilled! Reverently and thankfully I laid aside the Priestley manuscript.

"Now let me show you some other interesting old chemistries." Dr. Smith opened a beautifully bound tree-calf volume, and then one bound in pigskin. The title-pages were decorated with intricately enlaced floral and foliage borders. The titles and authors' names were done in exquisite letters with much ornamentation. At the bottom of the page of one book was a small cut, showing several cupids with bellows attending a fire. The text was illustrated. The engravings of distilling apparatus showed strange-looking flasks with long contorted necks. From the cubical furnace were issuing tongues of flame. Very different, indeed, is the make-up of the present day text-book.

"And now for my collection of autographs," said Dr. Smith, as he went to a steel case and pulled open a drawer. Here were piled manila folders, each one bearing the name of a country. The folders contained autographed letters from distinguished chemists the world over.

He had opened the France folder. "Perhaps you would like to see a letter from Lavoisier," and he handed me one. "Here is Pasteur's signature, and here is Madame Curie's."

Collections from other countries were examined. A letter from Fritz Haber, the greatest living German chemist, is a recent addition. He had been in this office in September, 1924. This suave little German had addressed an audience in the lecture-room across the hall, on the occasion of the Franklin Institute Anniversary celebration.

Along with each person's letter, Dr. Smith has placed one or more portraits of the writer. It may be only a newspaper clipping, or a small passport picture or a cabinet photograph.

"When I teach about the first synthesis of an organic compound from inorganic ones, I show my class this letter from Wöhler, who synthesized urea. It makes the subject more real to the student—these original letters and these portraits."

So at random, I opened the various folders and found letters and pictures of Arrhenius, Mendelejeff, and Emil Fischer. But why enumerate them? They are all there, in this priceless collection.

The time had sped on, while we were dipping into the past. I rose to go.

"You will come again, won't you?" asked Dr. Smith, as he gave me a hearty handshake. "I have still a lot of other trophies I want to show you."

Substance is like a river in continual flow; the energies undergo constant changes and cause work in infinite variety. There is hardly anything that stands still or remains still.—MARCUS ARELIUS

THE PECTIC SUBSTANCES

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At the Los Angeles meeting of the American Chemical Society last August, a group of about sixty chemists assembled for the purpose of holding a symposium on pectin. The event may be taken as an index of a considerable present activity in research on the pectic substances, and of a widespread general interest in pectin chemistry.

The pectic substances have a present claim upon the interest of intelligent people from at least three points of view: (1) the role of these substances in plant life, (2) their value in animal nutrition, and (3) their possible commerical applications. The role in plant life is placed first, partly because it is the most fundamental of these aspects, and partly because of the probability that it has an important bearing upon agricultural practices. The second phase, concerning the nutritive value of pectin, has so far received scant attention, but present tendencies indicate a greater interest in the future. The commercial aspects have attracted much attention within the last few years and it appears probable that the development of the industrial applications of pectin has only just begun.

In order to appreciate the significance of any of these three phases, some understanding of the physical and chemical nature of the pectic substances is necessary. Unfortunately our knowledge in that field is still far from complete, but researches which are now being carried out may be expected to reduce this deficiency to some extent. An attempt will be made here to outline some of the facts which have been established up to the present time and to indicate the trend of studies now under way and their application in the three fields mentioned.

Chemistry of the Pectic Substances

Just a century ago, in 1825, Braconnot[1] first isolated the jelly-making substance of fruit juices and called it pectin. This discovery was followed by the extensive researches of Fremy[2] and later by those of Scheibler,[3] Herzfeld,[4] Tollens,[5] and others.[6] The work of these investigators gave considerable information as to the occurrence and chemical nature of the pectic substances and many pectin preparations were made and named. It is uncertain how many of these preparations were individual substances.

The known pectic substances may be grouped into three classes:

(1) *Protopectin*, formerly called pectose, is the insoluble form which occurs in unripe fruits and in most other parts of plants. This substance, as its name implies, is the original pectic substance from which the soluble forms are derived.

(2) *Pectin* is a term used to designate the soluble pectic substances oc-

curring naturally in the juice of ripe fruits or obtained artificially by treating protopectin with mild hydrolytic agents.

(3) *Pectic acid* is obtained by subjecting pectin to hydrolysis. As will be pointed out later in this article, pectin is an ester which on saponification yields salts of pectic acid. Pectic acid occurs naturally in overripe fruits and vegetables.

The terms used to designate the individual pectic substances have been used differently by various investigators and as a result there has been much confusion in the literature. In an attempt to remedy this condition, a committee was appointed at the Los Angeles Pectin Symposium to study the existing nomenclature and make recommendations for the uniform naming of pectic substances.

The pectic substances were early recognized as closely related to the carbohydrates in that they yielded arabinose and galactose on hydrolysis. The early belief that they were true polysaccharides like starch and cellulose was shown to be erroneous when Tollens[5] demonstrated the presence of carboxyl groups. Since this discovery, the pectic substances have been recognized as carbohydrate derivatives possessing acid properties rather than as true carbohydrates.

In 1917, von Fellenberg[6] showed that pectin, on being treated with sodium hydroxide undergoes saponification like the fats, yielding methyl alcohol and the sodium salt of pectic acid, and from this he concluded that pectin is the methyl ester of pectic acid. In the same year Ehrlich[7] announced the discovery that the carboxyl groups of pectic acid reside in galacturonic acid, a sugar acid derived from galactose by the oxidation of its terminal alcohol to carboxyl according to the equation:

$$\underset{\text{Galactose}}{\text{COH.(CHOH)}_4\text{CH}_2\text{OH}} + \text{O}_2 \longrightarrow \underset{\text{Galacturonic acid}}{\text{COH.(CHOH)}_4\text{.COOH}}$$

Oxidation of the aldehydic group of the galactose molecule does not occur because of glycosidal linkage, the presence of which was demonstrated by the isolation of a galactose-galacturonic acid among the hydrolysis products of pectin.

By another type of hydrolysis, Ehrlich isolated from pectin a product in which four galacturonic acid groups have apparently condensed with the elimination of three molecules of water to give a tetragalacturonic acid. The sodium salt of this acid is obtained by alkaline saponification of the pectin, and methoxyl and galactose groups are simultaneously split off.

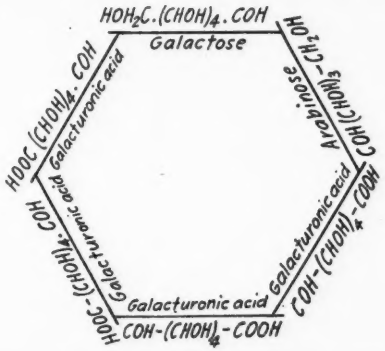
According to Tutin,[8] pectin yields acetone as well as methyl alcohol upon saponification; the acetone is believed to result from its isomer, isopropenyl alcohol $\left(CH_3—C\begin{matrix}OH\\ \diagdown\\ CH_2\end{matrix}\right)$ and pectin is regarded by Tutin as probably "the dimethyl-isopropenyl ester of pectic acid." On the other

hand, Norris and Schryver[9] maintain that acetone-forming groups do not occur in pectin and that methyl alcohol is the sole volatile product.

The work of these various investigators established, the presence in pectin of galacturonic acid, methoxyl, galactose, arabinose, and possibly other groups but gave no suggestion as to how these units were combined in the pectic complex.

The early elementary analyses were made upon preparations of uncertain purity and there was wide disagreement in the results. In 1916, Schryver and Haynes[10] prepared pectic acids from four different sources, which gave almost identical results on analysis. The values agreed with the formula $C_{17}H_{24}O_{16}$. More recently Carre and Haynes[11] showed that the substance was a calcium salt with the formula $C_{17}H_{22}O_{16}Ca$, from which they concluded that it was a diabasic acid.

Very recently, Nanji, Paton, and Ling have isolated a substance which they regard as the basic unit of pectic substances and which they find to consist of a hexa ring containing four galacturonic acid units, one arabinose unit, and one galactose unit, linked together according to the formula:



This unit has the formula $C_{35}H_{50}O_{33}$, and apparently is identical with Schryver and Haynes' pectic acid which gives very similar figures for the percentages of carbon, hydrogen, and oxygen. This formula accounts for the various hydrolytic products that have been obtained, for it is at once evident that such a ring could yield either tetragalacturonic acid, galactose-galacturonic acid, galacturonic acid, galactose, or arabinose. Pectin is the corresponding ester with the hydroxyls of the carboxyl groups replaced by methoxyl, $-OCH_3$. Intermediate products, corresponding to the partially methoxylated pectins described by von Fellenberg and Sucharipa,[18] are explained by assuming that only part of the carboxyls are methoxylated.

Still more recently, Norris and Schryver[9] have accepted the hexa-ring

structure of Nanji, Paton, and Ling,[12] and, on the basis of new data, have concluded that in the original pectic substance of the plant, three of the carboxyl groups are methoxylated while the fourth is free to react as an acid. Presumably it is the linkage with other groupings which occurs on this fourth carboxyl that distinguish protopectin from the soluble pectins.

Pectin as a Colloid

The pectic substances have long been recognized as typical colloids. When water is added to dry powdered pectin the pectin becomes hydrated and swells to form a gelatinous mass. Pectin solutions are probably not true solutions, but fine dispersions which upon the addition of alcohol coagulate to form gels. Many of the salts of heavy metals precipitate pectin gels. These precipitates were formerly regarded as metallic pectates and under some conditions it appears certain that such is the case, as, for instance, the calcium pectate of Carre and Haynes;[11] however, von Fellenberg[6] has pointed out that frequently the precipitation by metallic salts is to be regarded as chiefly the coagulation of a colloid by an electrolyte, since very small quantities suffice, and when the small limiting value is once exceeded, coagulation of the entire mass occurs.

Pectic acid gels are formed in aqueous solution upon acidifying hydrolyzed solutions of pectin. Certain plant enzymes are capable of producing similar gels from pectin solutions.

Stable gels are produced when solutions containing pectin and sucrose are concentrated in the presence of a small amount of acid under favorable conditions. Gels of this type constitute the well-known fruit jellies.

There is some disagreement as to the structure of these gels, but opinion seems to favor the view that they are solid solutions of concentrated sucrose solution in the coagulated pectin. The latter is regarded as having a cell-like, open structure which has been variously described in the literature as a "mesh,"[13] "honey-comb,"[14] or "brush-heap"[15] structure. The enclosed liquid is thought to be held in the minute interspaces by capillary forces. On this basis is explained the phenomenon of syneresis or "weeping" in which liquid runs out from the jelly without alteration of the structure of the gel.

Tarr[16] has submitted some data in support of his belief that pectin is an amphoteric substance, *i. e.*, capable of forming compounds with acids as well as bases, and that it has an isoelectric point like proteins.[17] Unlike the proteins, however, we are as yet unable to explain the chemistry of an amphoteric pectin. Much more information is needed on this aspect of pectin behavior.

Role of Pectin in Plants

As has been indicated earlier in this article, pectic substances occur widely distributed in all plants and in all parts of plants. This suggests

immediately that pectin probably plays an important role in the life processes of plants.

The primary function of pectic substances in plants is the cementation together of the individual cells of which the plant is composed. The original cell wall may be assumed to consist at first of pure cellulose, but where two cells adjoin, an intermediate layer is formed, which is designated as the middle lamella, and this layer consists largely of protopectin.

The chemical nature of the protopectin in the original plant cells is a matter which has been subject to considerable dispute. The older investigators believed the original pectic substance to be calcium pectate. Von Fellenberg questioned this on the ground that treatment with dilute acids of varying strengths dissolves pectin and calcium in proportions that bear no relation to each other. Recently Sucharipa[18] has presented evidence that protopectin is a combination between pectin and cellulose; upon hydrolysis of protopectin, free pectin and free cellulose are liberated in uniform proportions. This view is consistent with recent data by Norris and Schryver[9] although these investigators apparently regard the union as occurring with calcium or other metals rather than with cellulose.

The real existence of protopectin has been questioned recently by Tutin[19] who found that all of the pectin of apples may be dissolved by boiling with water, provided the material is previously ground finely to break up the protective cell-walls. Carre[20] has contended, however, that Tutin's views cannot be maintained by the evidence that he has presented. The results of Sucharipa[18] and of Norris and Schryver[9] appear to indicate definitely that the original pectin substance exists in a form distinctly different from that of the soluble pectins obtained on hydrolysis.

Upon the ripening of fruits, protopectin is largely converted into pectin. As the fruits become over-ripe, a further reaction occurs in which the pectin is converted into pectic acid. These chemical changes are clearly indicated by changes in texture for which they are probably responsible. In unripe fruits, the union with cellulose maintains the firmness of the tissues. In fully ripened fruits, the breaking of this union produces a softer tissue, while in over-ripe or rotten fruit, methoxyl groups are split off and the tissues are completely disintegrated.

The hydrolysis of pectic substances which occurs in the ripening of fruits is produced by the action of enzymes. The enzyme which breaks protopectin down to pectin has been designated *pectosinase*, but perhaps should be called *protopectinase* to conform to modern nomenclature. Fremy[2] has described two other enzymes: *pectase* which converts pectin into pectic acid which then becomes a gel, and *pectinase* which hydrolyzes pectin and pectic acid into their simplest cleavage products (galacturonic acid, galactose, arabinose, etc.) It is by means of the pectin-splitting enzymes that parasitic fungi are able to penetrate the cell-walls and thus gain entrance into the host plant.

From recent investigations by Nanji, Paton and Ling, it appears probable that the pectic substances in plants are formed from a hexagalactan by oxidation and methoxylation. The hexagalactan, in turn, may be regarded as a condensation product of galactose which is formed directly by photosynthesis in the leaves or by conversion of one of the other synthesized sugars. It is thus possible to account for the synthesis of pectin in the plant from carbon dioxide and water.

Von Fellenberg believes that pectin undergoes conversion into lignin, since the increase of lignin in growing twigs occurs simultaneously with a decrease in pectin. The presence of methoxyl groups in both substances indicates the possibility of a relationship between them.

The presence of pectic bodies in the root hairs of plants indicates that these substances may play a part in the absorption of nutrients from the soil. According to R. H. True,[21] the injury to plant roots grown in alkali soil is to be ascribed to a breaking down of the pectic substances by interaction with alkaline salts.

Food Value of Pectin

Although the amount of pectin which is consumed in jellies, jams, etc., is too small to have any significance in the diet, noteworthy quantities are consumed in diets which include a considerable proportion of fresh fruits and vegetables.

From the nutritive point of view, the pectic substances are usually regarded as belonging in the same general class as cellulose and the hemi-celluloses, and consequently as having but little food value. It has been suggested by Ehrlich that although neither pectin nor pectic acid are affected by the ordinary carbohydrate enzymes and, therefore, probably not assimilated, it is possible that more exact studies may show that pectin has a food value. It may be found practicable to increase this by artificial hydrolysis.

The dietetic value of the succulent fruits and vegetables has been clearly recognized in recent years. Their usefulness has been ascribed variously to their bulkiness, to their mineral salts, and to the vitamins which they contain. It is perhaps worthy of note that these foods contain considerable quantities of pectic substances, and it appears possible that these bodies may, in some way not yet understood, contribute to the usefulness of the succulent foods.

Commercial Applications

Practically the only application of pectin has been in the manufacture of fruit jellies. In order that a fruit juice may produce a jelly when it is boiled with sugar and acid it must contain a sufficient quantity of pectin. In some fruit juices the natural pectin content is high enough to produce a good jelly; others are deficient in pectin and will not jell unless pectin be

added. Formerly it was customary to increase the pectin content of deficient fruit juices by adding the juice of other fruits that have a higher pectin content, such as apple juice. This procedure has the disadvantage that a foreign flavor is added and in the case of delicately flavored fruits the desired purpose is defeated. With the advent of commercial pectin, it has become possible to add pectin to juices without introducing foreign flavors or colors; in consequence, a new field in the preparation of attractive food products is opened up to housewife and manufacturer.

Commercial pectin is now manufactured on a considerable scale. Although pectin can be made from most of the fleshy root vegetables and from many fruits, the raw materials of the American pectin industry have so far been confined to two waste products: apple pomace from cider mills and cull lemons. Only a small fraction of the available quantity of these waste materials is now utilized in pectin manufacture and there are other vast sources of pectin.[22] The pectin industry is, therefore, capable of great expansion if a sufficient outlet can be found for the product.

In manufacturing pectin from apple pomace, the raw material is usually given a preliminary washing to remove the greater part of the coloring and flavoring substances which still remain in the pulp. The residue is then boiled with slightly acidified water, whereby the pectin is largely dissolved. The solution is separated from the pulp and evaporated to a thick sirup or to a dry powder. Since some of the color and flavor of apples still remains, it is not possible to obtain a pectin of high purity by this process.

The manufacture of pectin from citrus waste[23] begins with the residue remaining after the manufacture of citric acid. This is washed with cold water to remove soluble impurities, then extracted by digesting at 90°C. with a solution of sulfurous acid. The pectin is removed from the resulting solution by colloidal precipitation with aluminum salts. The precipitate is then dried and ground to a powder. Aluminum salts and other impurities are removed by washing the powdered pectin, first with alcohol containing hydrochloric acid and finally with neutral alcohol. A very pure product results.

Fruit jellies are formed when fruit juices containing sufficient pectin and acid are boiled with the proper proportion of sugar and allowed to cool. If the juice is deficient in either pectin or acid, these must be added in order to obtain a satisfactory jelly. Many investigations have been made to determine the optimum proportion between pectin, sugar, and acid for the production of a good jelly. It has been found that considerable variation may occur and that an increase in acidity may, within certain limits, partly compensate for a deficiency in pectin. Poore[24] places the lower limits for a satisfactory jelly, as 0.045 per cent for citric acid, 0.20 per cent for pectin, and 37 per cent for sucrose.

There has been considerable disagreement as to the concentration of

acid required for the production of a good jelly, but Tarr has pointed out that, if due regard be paid to the resulting hydrogen-ion concentration of the various acids under consideration, the results are in fair agreement. According to Tarr,[16] jelly formation begins when an acidity of p_H 3.46 is reached. When the acidity is increased to p_H 3.2 to 3.1, the gel increases in stability. Beyond p_H 3.1, there is no increase in stability, but syneresis or "weeping" of the jelly occurs.

At p_H 3.37, if the proportion of sugar to pectin is greater than 65:1, the resulting jelly is not firm enough to stand. If the p_H be increased to 3.1, it is possible to increase the ration of sugar to pectin to 85 or 90:1. A satisfactory jelly may, therefore, be obtained by first adjusting the acidity between 3.1 and 3.37 and then regulating the sugar : pectin ratio to a somewhat smaller value than that for the corresponding maximum as given above. An excessive proportion of pectin should be avoided, however, as a tough jelly is thereby produced.

Not all pectins are equally suitable for jelly making. Fully methoxylated pectin gives a thick sirup instead of a jelly, and completely demethoxylated pectin, or pectic acid, separates from the solution in clumps and consequently produces no gel. The best jellies are obtained with the partially methoxylated pectins intermediate between these two. Too long boiling may hydrolyze the pectin partly to pectic acid and so prevent jelly formation.

In view of the unusual properties of the pectic substances and their great abundance in nature, it may be confidently expected that many new uses will be found for these substances and that a great pectin industry will be developed in consequence.

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Microscopic Fossils to Aid Oil Seekers. A new scientific body composed of American geologists interested in the microscopic study of fossils has been formed, following the national meeting of the American Association of Petroleum Geologists at Dallas, Texas. The society is composed of micropaleontologists throughout the country and is an organization of specialists within the larger petroleum body. Numbered among the pioneers in the movement to organize this society are several widely known paleontologists who for years have been devoting their time to research work in the field of microscopic investigations of fossils.

During recent years it has been learned that one of the most authentic ways to solve the riddle of the past is to study the relics of the ancient world by examining the minute particles under the microscope. This instrument, long valuable to the student of pathology and bacteriology, is rapidly becoming one of the most valuable assets in the hands of the student of prehistoric life.—*Science Service*

Government Perfects System to Make Unbreakable Glaze. Housewives and incidentally the whole ceramic industry need no longer suffer great losses in temper and in money from the cracking of the glaze on kitchen pots and pans. Experts of the U. S. Bureau of Standards have developed a system of measuring the rate of expansion of the glaze used on pottery and enameled ware that will help manufacturers in making a product, the surface of which will not crack.

All glazed ware consists of a body of clay or metal covered with a thin glassy layer having a composition quite different from that of the base. These two different materials expand at different rates when heated. Thus there is considerable strain when the glazed object contracts on cooling down from its firing in the furnace. The strains suffered by this brittle glaze, only one two-hundredth of an inch thick, during the annealing process, reduce its resistance to the many stresses it must endure in the course of a more or less hazardous existence in the kitchen sink and on the dining-room table.

Manufacturers, keenly alive to the vital bearing of these facts on the development of their industry, have contributed generously to scientific research on this problem in university laboratories, hitherto without avail.

In a long series of experiments, in which the exact conditions of manufacture were reproduced, C. G. Peters and G. E. Merritt of the interferometric section of the Bureau of Standards have perfected a system for measuring the rate of contraction and expansion of the different glazes in commercial use. By applying this general method to their individual problems, manufacturers of every variety of glazed ware, from bric-a-brac to bathtubs, will be able to ascertain their errors. They can then turn out products the surfaces of which do not "craze" either in the making or subsequently, with consequent saving to both producer and consumer.—*Science Service*

THE HANDLING OF MATERIALS AND APPARATUS IN THE HIGH-SCHOOL CHEMICAL LABORATORY

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One of the greatest problems connected with laboratory instruction is the furnishing of the laboratory with its first supply of materials and apparatus. The keeping of a proper supply from year to year is not much less of a problem and this requires even more time. The industrial laboratory, limited to a special line of manufacture and a narrow field of investigation, can be supplied rather easily and without spending much time listing the materials needed. In order to make an ample list of the necessary materials for a course of instruction the same plan as for the industrial laboratory has to be followed, excepting that a wider field has to be covered. Some manuals provide a list to correspond to the exercizes in the manual, but since the instructor rarely applies the manual completely, but works out improvements from year to year it is necessary to go through every experiment planned for the course, every year and make a list of materials to correspond to the coming year's plans.

Of course after the first year the plan must be gone over each succeeding year and also the materials already on hand must be invoiced. This is the least that will guarantee a complete list. The great advantage in having a list to cover the amount for the entire year, is in the saving of expense. A list put in the hands of the purchasing agent who will submit it to different firms for bids, is most liable to meet with the best possible financial proposition. Another advantage is in that the transportation is always much less on bulk shipments.

We are not advocates of the idea that the cheapest is the best but in the case of most laboratory apparatus, especially glass ware, which generally lasts until it is accidentally broken, the cheapest is the most economical. This could not be said of chemical reagents. The industrial chemist would say, use commercial chemicals wherever possible and save expense. The chemistry teacher should say, use for the most part, chemically pure materials, figure accurately, be neat and clean, insist on perfection as far as possible in every respect.

There are not many dollars gained in an entire high-school course in chemistry by using commercial materials. W. B. Adkinson[1] gives a list of directions for cutting down expenses in the laboratory. Some are good but some are not so good. His suggestion regarding the use of sodium compounds instead of potassium is good, as is also his suggestion regarding the use of potassium chlorate instead of potassium permanganate in making chlorine, etc. But these two suggestions have nothing to do with the purity of the substances. His suggestions regarding the use of impure manganese dioxide as obtained from dry cells, and zinc obtained

[1] *Sch. Sci. Math.*, **17**, 643 (1917).

from such a source, would promote more of a waste of time than it would a saving of expense. Of course, there is some educational value in taking down dry cells. Many directions calling for acids, specify sulfuric instead of hydrochloric when either would serve, merely because sulfuric is less expensive. The fact is that in most cases the student wastes time and has unpleasant and unprofitable experiences diluting the sulfuric to the proper concentration. To sum up the matter of economies, we have carried out some computations with the manganese dioxide, zinc, and sulfuric acid, and find that the instructor or student can save only from five to ten cents per hour for his labor in this way.

It might be said that in many cases commercial products could be bought directly at a less expense and that the student would not need to purify them. That may be granted but in the reactions of the impure substances, in too many cases, an untrue story is developed as far as color or some other property is concerned.

We would not discourage the use of commercial products altogether for the reason that there are some cases in which the commercial reagents work equally as well as the chemically pure ones and at the same time bear the lesson of economy and tell the story of some of the reagent's properties. This is true in the case of two or three acids commonly used, but is not the case for the great majority of the salts and solids of various kinds.

Probably the greatest time-saving agency and the most economical and educational elements in the entire laboratory proposition are in the things that relate themselves to system and order, and in the understanding and coöperation of students and instructor in that system and order.

C. J. Quick[2] intimates that it does not make a great deal of difference what the system is, but that there must be a system.

There are, of course, different good systems to be adopted in connection with the stock room and its stock keeper. It goes without saying, too, that there are many more in number, and more widely differing systems where there is no stock room with a stock keeper. These differences, of course, depend largely on the arrangements of the laboratories and the work cabinets within them. While there should be organization and system in the keeping of stock on side shelves and in cabinets, there is such a thing as having a system too complex. If the department has over two hundred students and one laboratory demanding more than two series, side shelves, cabinets, and tables furnish sufficient convenience providing the organization and system is neither too simple nor too complex.

Quick says, regarding the arrangements of materials on shelves and in cabinets, that every course should have its own series of side shelves and cabinets, and that every material should have its number labeled on it to correspond to the number labeled on the shelf. Regarding separation for

[2] *Sch. Sci. Math.*, **19**, 123–30 (1919).

separate courses, we would say, if there is a large number in each course, separation of the materials for the courses should be made.

As to the numbers labeled on the materials and their places on the shelves, we believe that is too much trouble in view of the benefit derived from it. We have tried the plan and soon abandoned it. The plan has the following difficulties: The supplies of materials, even though separated from the general stock and placed on special side shelves, are changing in kinds and amounts so that it is very difficult to keep the numbers up with the changes. The growing laboratory in the growing department is constantly being added to. This, of course, could be cared for by placing letters after the numbers on the materials, or by applying some such library system, but the numbers on the shelves would have to be removed and readjusted with every new addition or else we would have to look ahead and be able to figure out what was to come in and leave space sufficient between every two numbers. Then, too, many of the materials cannot conveniently be placed in the same old bottles or kept in the same form. As far as we were ever able to determine, these corresponding numbers were supposed to enable the worker to readily see where to return the material when he was through with it. In our own experience, we never had any better coöperation from the students in returning materials according to shelf numbers than we had in any other system. According to Quick, the system of numbers was supposed to help the student find the material, for he would have separate lists in the hands of the students for each of the separate experiments, having on these lists the shelf numbers of the materials. We should say here again is added trouble for the instructor in order to make it easy for the student. This too would create a lack of pedagogy. The student should not do any experiment by adding 47 to 52 shelf numbers, but by adding hydrochloric acid to sodium hydroxide.

Some six or seven years ago there was considerable attention and some serious thought given to the Freas system.

W. L. Estabrook[3] enumerates the advantages of the system as follows:

1. It relieves the instructor of handling supplies.
2. It saves students' time by having all supplies at the desk.
3. It insures pure and clean chemicals.
4. It is economical by giving out just enough.

Estabrook then cites cases in New York where students have been able to do double the amount of laboratory work on account of applying the system.

A. A. Blanchard[4] sets forth the disadvantages of the system as follows:

1. It reduces instruction to lifeless routine.
2. It makes a framework about which courses must be built to fit.

[3] *Science*, **49**, 506 (1919).
[4] *Ibid.*, **50**, 112–4 (1919).

3. It stresses material output rather than material development.
4. It makes work too monotonous for the student.

Blanchard backs up these assertions with excellent arguments on the side of educational values as against factory efficiency.

Eastabrook,[5] comes back at Blanchard, relating how he has visited schools where the students were wasting and polluting materials by breaking up lumps with a rusty iron ring.

Since reading these controversies, we have made some rather careful calculations and observations in our own laboratories, and have found by means of a questionnaire the proportion of schools in the North Central Association using the different systems. We found from 250 responses to the questionnaire, seven were using the Freas system. Four schools were using the student trusty system. Certain trustworthy students were selected to distribute the materials as they were needed by the workers. In making estimations as to time required to issue materials, we had to conclude that about the same time was required in one system as in another as to saving the instructor's time, for no system demands that the instructor do this work. This, of course, would throw the whole burden of the argument on the proposition of saving proper amounts of materials and giving the student pure stuff. As to the latter two phases of the proposition, we have followed each day's work for the past two years, roughly estimating the value of materials spilled and used as excess. For an average of one hundred students working two days per week, we determined that not more than ten cents worth of materials could have been wasted per day. This would amount to seven dollars per year. Seven dollars would not begin to hire help enough to supply each desk with the materials according to the Freas system. This leaves the entire weight of the argument on the phase of the students' time.

We believe it would not be worth the while to devote separate pages to all of the arguments proving that the thinking and figuring as to amounts, the looking over formulas in organized arrangements of materials, the measuring and weighing, and getting things ready for an experiment, furnish as much educational value for the time spent as any other phase of the laboratory work. In this connection we will describe the system which has served very well in many cases, and which seemed to be used by 239 schools out of the 250 responding to the questionnaire.

Breakable apparatus such as is charged to the student's desk is all that is kept in a locked cabinet, not that the lock prevents the breaking, but this is the only kind that ever mysteriously disappears. Expensive apparatus which is not furnished to each desk is kept in some convenient place and loaned to the students as it is needed. Groups of students are generally combined to do the experiments calling for expensive apparatus.

[5] *Science*, **51**, 155–9 (1920).

If the group breaks apparatus of this kind they are expected to charge it on their breakage account which is posted somewhere in the laboratory.

Reagents are kept on side shelves for the most part and conveniently arranged so that the students may help themselves. The common mineral acids and alkalies are furnished to a set of shelves over each work cabinet where several students work at a time. The solid acids, the solid salts, the oxides and sulfides, the liquid acids, the salt solutions, and the most commonly used liquids of a miscellaneous class are all kept on separate series of shelves. These reagents are labeled with their chemical formulas and arranged in alphabetical order. This means that the student must make himself acquainted with common properties and formulas before he knows what series of shelves to go to. It also means that the thing is not hard to find after he knows where to go for it.

It is only the less expensive and commonly used apparatus which is furnished to each personal desk. For this sort of apparatus the student is asked at the beginning of the year to make a breakage deposit. An invoice is made at the beginning and at the end of the course, and for all that is not found in the desk at the end of the time the price is taken from the deposit. The student pays for the reagents also by paying a three dollar fee at the beginning of each quarter. To make the system as simple as possible for the student's sake, all rare materials and those rarely used are kept in a room convenient to the instructor's office, and they are issued by the instructor when needed.

Surplus and extra stock is kept also in some such room, in alphabetical order to some extent, but largely to suit the arrangement of the room. This does not need to be a large room for a department of two hundred students. In fact in our department it is one end of our office.

In our experience with this system, as far as general training in a chemical laboratory is concerned, we have arrived at the conclusion that everybody concerned gets value received for all the trouble he is put to with one possible exception, that is, the instructor has to continually remind the students of the importance of putting things back where they belong. But even this ultimately results in a type of training which the student needs.

ORGANIC SYMPOSIUM PAPERS READY FOR DISTRIBUTION

The *News Edition* of *Industrial and Engineering Chemistry* announces that sets of the papers presented at the First National Symposium of Organic Chemistry are available for distribution in mimeographed form at one dollar per set. Those desiring to order should communicate at once with the secretary of the Division of Organic Chemistry, F. C. Whitmore, Chemistry Department, Northwestern University, Evanston, Illinois.

PORTLAND CEMENT RESEARCH*

P. H. BATES, BUREAU OF STANDARDS, U. S. DEPT. OF COMMERCE, WASHINGTON, D. C.

About a hundred years ago Joseph Aspdin of Leeds, England, took out a patent covering the manufacture of a cementitious product which commerce has chosen to call "Portland cement" on account of the marked resemblance of the hardened mixture of this cement with sand to a natural stone occurring near Portland, England. The fact that even at that time there was at least one person who was interested in the production of such inorganic cement to the extent of taking out a patent covering its making indicates that there was study and research of cements under way then. Indeed one of the broadest and most interesting researches of this type had been conducted and the results published in 1818 by Vicat, the Frenchman whose name is familiar to all those engaged in testing cements, through the device, the Vicat needle, which he designed and which is still used for determining the time of set of cement. But just as research had been under way before Aspdin patented his methods so had Portland cement been manufactured before his patent was granted. Wherever impure limestone of a certain composition had been calcined and the temperature reached or exceeded 1350°C. we know Portland cement had been formed, but, as Vicat mentioned, had been discarded either on account of the difficulty of reducing the hard nodules to the needed fine powder or through its lack of ability to hydrate as quickly as quicklime.

But even though this product is of such an age it must be considered a very modern material since it is a fact that commercially or scientifically it did not come into its own until the beginning of this century. This can be realized from the commercial viewpoint by the figures of production in the United States, issued by the Geological Survey. In 1892 the total production in this country was but little over half a million barrels. In 1902 this had risen to about seventeen million barrels and last year it was about 155,000,000 barrels, or in terms of the unit more familiar to all—the bags, of which there are four to the barrel—620,000,000 bags. It can also be realized from a scientific viewpoint by the work of the Geophysical Laboratory on the silica-lime-alumina minerals, starting about 1906, which work is internationally considered as having advanced our knowledge of the constitution of Portland cement more than all previous investigations, and has indicated the methods to be used in studying the effects of other oxides which are also present.[1]

But with this work at hand our fundamental knowledge and methods are but placed upon a firm basis which can serve as a starting point of the

* Published by Permission of the Director of the National Bureau of Standards of the U. S. Department of Commerce.

[1] See the work of Day, Shepherd, Wright, and Rankin in the *Am. J. Sci.*, **22**, 265 (1906); **28**, 293 (1909); *J. Ind. Eng. Chem.*, **3**, 211 (1911); *Am. J. Sci.*, **39**, 1 (1915).

research of which so much is yet to be done. The status of research in Portland cement can best be visualized by a slight review of the work of the Geophysical Laboratory in so far as it refers to Portland cement, and by presenting briefly a resumé of the nature of the raw materials from which this commodity is made, the nature of the processes of manufacture, the character of the product itself, and of its reactions with water.

The work of the Geophysical Laboratory was directed largely to the application of the phase rule to the study of equilibria in the lime-alumina-silica system. The stability relations of the four distinct compounds existing in cement were determined, as well as their compositions and optical properties. The magnitude of the work can be appreciated by the fact that 7000 heat treatments and subsequent optical examinations were made. It was found that there may exist in Portland cement but two silicates, $2CaO.SiO_2$ and $3CaO.SiO_2$, and but two aluminates, $3CaO.Al_2O_3$ and $5CaO.3Al_2O_3$. None of the other lime silicates or aluminates or lime-alumina silicates or alumina silicates exists in the normal, properly burned product such as meets the requirements of the specifications of either the Government or the American Society for Testing Materials.[2]

But it can readily be understood that if these alone exist in the finished product chemically pure raw materials must have been used. Commercially, of course, this would not be possible. Hence, recourse must be had to those naturally or artificially occurring materials which are of such a composition that they may be used. Bearing in mind that Portland cement, to have the demanded physical properties, must have a chemical composition of from 19 to 23 per cent silica, 5 to 9 per cent alumina, 62 to 66 per cent lime, and the remainder impurities, one realizes that the artificially available materials are slag and alkali wastes and the naturally available are clay and limestone and marls. But these always contain such impurities as iron oxide and magnesia in appreciable amounts and the oxides of manganese, titanium, sodium, and potassium in lesser amounts. As in the finished cements these would exist in amounts of from 4 to 9 per cent one can readily understand that they may markedly affect either the process of manufacture or the product. While it may be questioned if it is really necessary to study these impurities in the compounds in which they may be found, there need be no doubt in regard to this. The use of very low iron oxide materials such as are used in making white Portland cement immediately entails changes that result in a different composition and slightly different physical properties when compared with the properties of the usual gray Portland cement with a content of about 3 per cent Fe_2O_3. When, in addition, the magnesia is reduced in the raw mixture

[2] Federal Specifications Board, Specification No. 1; Bureau of Standards, *Circular* No. **33.**

American Society for Testing Materials Standard, Serial 09–21.

through the use of some of the very low magnesia limestones, a cement is obtained not only at a much higher cost but of such setting properties that it is not a commercial structural product.

At the Bureau this work of the Geophysical Laboratory is being extended to include the effects of the oxides of iron and magnesia and the volatile alkalies on the silicates and aluminates of lime in that section of the field of the lime-alumina-silica system wherein lie the compositions corresponding to Portland cement. Primarily the new compounds, if any are formed, will be studied and their conditions of equilibrium and their chemical and optical properties noted. In addition, their constitution will be studied by means of the X-ray diffraction methods.[3]

In addition to investigations of raw materials for determining the effect of impurities such as just outlined, there must be some research carried out showing the effect on the finished cement of the use of raw materials of different origin, degree of fineness, and homogeneity, but of closely the same composition. The industry in the United States originated in a section of the country where an impure limestone of the composition required for making Portland cement was at hand. This raw material having the various oxides extremely intimately mixed gave a cement of excellent quality. When, however, commercial conditions necessitated the use of other raw materials it was noted that a product of somewhat different character was obtained under similar conditions of manufacture. It became quite evident that the raw materials would affect the quality of the cement and the economy of production. While the opinion is generally held that this is due to the lack of intimate mixture of the several raw materials or the lack of the required degree of fineness, there is still considerable doubt as to the validity of these ideas for which there are no definite data.

This is a problem that has been studied in a minor way at the Bureau and remains to be taken up when coöperation can be had with the cement-producing plants whereby it will be possible to burn, under identical conditions, raw mixtures of different origin but of the same chemical composition and fineness. While there is but little doubt that at equilibrium all should give the same results, there is also little doubt that equilibrium would be reached with widely different economy of production or fuel.

The process of manufacture is practically the same throughout the United States. The raw materials after blending in the required proportions are ground and burned in a rotary kiln and then reground. But

[3] The reader should consult any of the following publications of the Bureau for a more detailed idea of its work along the lines discussed in this paper: Bureau of Standards Technologic Papers Nos. 3, 12, 43, 78, 102, and 197; *Trans. Am. Cer. Soc.*, **15,** 420 (1913); **16,** 551 (1914); *J. Am. Cer. Soc.*, **1,** 679 (1918); *Proc. A. S. T. M.*, **15,** 128 (1915); **19,** 425 (1919); **23,** 160 and 248 (1923); *J. Frank. Inst.*, **193,** 289 (1922).

just as the different raw materials require different degrees of grinding, so the burning time always varies with the type of raw mixture. Just how these variables affect the formation and the character of the formation of the constituents of Portland cements has not been well defined. This problem, however, fits into the previous one very nicely and the two might well be conducted at the same time. For instance, during the burning we first have dehydration, decarbonation, and then the reaction between the oxides. Consequently, from a temperature of about 1000°C. to that at which the burning is completed—1350°C. to 1450°C.—there is no change in chemical composition excepting a reduction in the volatile alkalies if present. But there is a marked change in the appearance of the material and its properties. The former changes from a light yellow-brownish powder to a black, hard clinker and the latter from a material reacting with water as readily as quicklime to one apparently unattacked by water. With most raw materials satisfactory clinker is not obtained short of 1400°C., but while the macroscopic appearance does not change as the temperature is increased the microscopic appearance of a thin section shows decided changes. This consists largely of an increase in size of the crystals of the constituents and, while some work has been done on studying the effect of the relation of the grain size of the constituents of cement to its property as a cementing medium, considerably more must be carried out.

Normally burned clinker shows that the constituents above indicated exist in a very heterogeneous mixture in any one piece of clinker. These constituents are bounded generally by an unknown flux composed largely of the impurities, and unless the clinker has been very hard-burned there is no distinct crystal edge. On the other hand, the crystals of the individual compounds seem to blend into the flux or one another. The pieces of clinker may vary from pea size to balls a foot or more in diameter. The studies that have so far been made on the nature of cement apart from its constitution have been largely such incidental plant investigations as would show the relative plant economy in producing a large or small-sized clinker, the economy of grinding the several types, and the strength characteristics of the ground clinker when mixed with water.

Portland cement is of value commercially only because it is partially soluble in water and some products of the reaction have the property of coalescing and cementing themselves or other bodies together, provided an excess of water is not used. But the clinker presents such a small surface to the water that little bond can be obtained. Hence the surface must be increased by reducing the particles to a small size. At the present time the standards demand that 77 per cent must pass a No. 200 sieve. But such ground material reacts so rapidly with the water that the reaction must be delayed. Otherwise it cannot be used commercially. Conse-

quently, in grinding, the clinker is mixed with about 3 per cent of gypsum to effect this delay in the reaction.

When this ground, retarded cement is mixed with water a very simple test would show that the latter immediately becomes alkaline. Further tests would show that this is due to the presence of lime in the solution. If the cement is placed with an excess of water in a closed container and allowed to remain quiescent, in the course of a week or more, hexagonal plates or needles will form. These are hydrated lime. On occasions one other form of crystals may be seen in Portland cement after hardening. This is in the form of very slender tufts of needles which has been found to be $3CaO.Al_2O_3.3CaOSO_4.42H_2O$. There is some amorphous material also present, generally believed to be one or both of the silicates from which the lime has separated. But though *Technologic Paper*, No. **43** of the Bureau gives some very valuable information regarding the hydration and hydrolysis of the pure compounds which may be present in Portland cement, it has been but recently possible to extend the study to the very complex commercial material itself. This phase of cement research is of extreme importance since the durability of products made from cement depends so much upon the reaction with the water proceeding in a well-defined but not well-understood manner. Furthermore, the problem is complicated by the impurities existing in most waters and especially in those very impure ones such as sea waters, in which cement products are placed. Also it should be remembered that the reaction of cement and water is not immediate, or completed in a short time, but continues almost indefinitely as long as water is in contact with it. Hence the reaction which may be started properly may be entirely rearranged at a later time by contact with impure water. Finally it should be stated that the character of the reaction with the necessary impurity—gypsum—added to Portland cement to retard its set, is not known.

Before closing this paper attention should be called to a rather too general lack of appreciation of the importance of more emphasis in the teaching of the origin, properties, and value of what for a better name are called non-metallic commodities. Portland cement being one of these is a good example, but the lime, magnesia, stone, silica (including sand and gravel), and clay industries must also be remembered. The Portland cement industry produced last year a little more than 25,500,000 tons of cement. This was composed approximately of 19,000,000 tons of equal parts of tricalcium and dicalcium silicate, 4,500,000 tons of tricalcium aluminate and the remainder, 2,000,000 tons of unknown compounds. Curiosity alone of those engaged in chemical research would surely justify work to find out what these 2,000,000 tons of material worth approximately $27,000,000 actually are. How many students in inorganic chemistry are told that there is such a material as tricalcium silicate or that it is

produced to the extent indicated above, at a value of about $145,000,000 annually? The other products mentioned furnish just as striking examples. The idea held by many is that clay is a peculiar earth, capable of being made into a brick or, when white, of being made into pottery. Few realize that silica and feldspar may constitute as much as 35 per cent of this latter commodity, or that somewhat more than 300,000 tons of clay annually enter into paper and are actually present in the finished product and sold as such. Nor should we lose sight of the fact that the metallic industry is dependent upon the non-metallic for its existence. The metals are produced in furnaces built externally and lined internally with clay, silica, magnesia, or chrome products. Indeed if there be a basic industry it is not a metallic but a non-metallic one and furthermore it can be based upon as thorough a chemical foundation as the metal industry when it has received its due and much needed attention from those engaged in research.

Cramming No Help to College Students. Cramming the night before examinations may pack college students' minds with erudition, but the vigil will make them so sleepy that they will not be able to make efficient use of their hastily acquired learning when the test comes. An experiment on five Stanford students by Herbert R. Laslett, a graduate student in the department of psychology, indicates that lack of sleep has a deteriorating effect on the "higher mental powers."

The experiment in question lasted 72 hours. For three nights the five boys remained awake and performed various tests in the department of psychology laboratories. At intervals they were given intelligence tests.

Mr. Laslett expects to determine by further experiments whether there is any basis for the theory that sleep may be a "habit," and may not be necessary to physical well being. Napoleon is pointed out as an example of a man who had very little sleep and proponents of the "sleep habit" theory declare that man may be able ultimately to break the habit and do with little or no sleep.

The Stanford tests, Mr. Laslett said, show that loss of three nights' sleep is not physically harmful. All his subjects were given physical examinations by an attending physician at intervals.

In commenting on the tests, he said:

"While it is quite possible that the story of Napoleon living twenty years with an average of less than four hours' sleep a night has a real foundation, this may be due to the fact that sleep has depth as well as length, and it is possible for a man to sleep 'hard' and derive whatever restorative effects sleep may have in a short time.

"The experiment we conducted at Stanford indicated in its general results that lack of sleep causes a definite lowering of the higher mental faculties, an inability to concentrate and reason with normal accuracy.

"It was believed that the test might indicate the areas which cause sleeplessness—the optic nerve, or areas in the cerebrum or cerebellum, but the effect of sleep is so complex that it is impossible, as far as we have gone, to determine the relation of the various parts of the nervous organization to the apparent need of sleep."

Generally stated, said Mr. Laslett, the loss-of-sleep test showed that persons who give up their nightly rest will suffer greatly in a lowered mental capability, while their physical well-being will not be greatly affected by this specific factor.—*Science Service*

MENTAL PROCESSES REQUIRED IN RECENT EXAMINATIONS IN CHEMISTRY. II

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In a recent article in THIS JOURNAL[1] I have presented the results of a tabulation of mental processes required in the examinations of the College Entrance Examination Board between 1916 and 1922. Mr. J. L. Whitsit, of De Witt Clinton High School, New York, N. Y., who saw the manuscript of that article, was of the belief that a similar tabulation of more recent examinations would show an appreciable change in mental content; upon his suggestion, the present study of examinations from June, 1923, to January, 1925, has been made.

The methods used and the bias against memory-work are the same as in the previous article mentioned, except that a still more consistent effort has been made to count non-memory items whenever possible. The classification of items is identical with that in the previous paper and, for continuity, the tables are numbered in continuation of the series there begun.

As in the previous paper, the material is summarized in the two tables, first in its raw state and then adjusted by the same apportionment of equations and computations between memory, habit, and thinking.

The figures would indicate the following conclusions:

(1) Since 1922 the similarity in apportionment of mental processes between College Board and Regents' examinations has continued unchanged as compared with the similarity existing before that time.

(2) Since 1922 both sets of examinations show a distinct increase in the amount of memory-work required, with the relative proportions of habit and thought material unchanged in the remainder, as compared with examinations before that date.

(3) The commercial uses, properties, and manufacture of substances have steadily gained in number of questions asked, during this period and as compared with earlier examinations, in both Board and Regents' examinations.

(4) Verbal-memory questions have diminished in numbers as compared with examinations before 1922.

(5) On the whole, the character of the examinations, despite the introduction of sets of true-false questions in the Regents' papers, has not changed sufficiently to warrant the conclusion that there is any improvement except the smaller amount of theoretical material and larger amount of applied chemistry required to be remembered.

It also may be noted that the Board examinations show an additional difference from those of the Regents, not previously noticed but apparently carried over from earlier years. In the two Board examinations, 13 questions require not only chemical knowledge or abilities, but

[1] "Mental Processes Required in Examinations in Chemistry," THIS JOURNAL, 3, 445–9 (1926).

TABLE V

DISTRIBUTION OF MENTAL PROCESSES REQUIRED IN THE VARIOUS GROUP EXAMINATIONS

Group	Nature of mental process	Board Number of responses 1923	1924	Total	Total per cent of responses	Regents Number of responses June, 1923	Jan., 1924	June, 1924	Jan., 1925	Total	Total per cent of responses	All examinations Number of responses	Per cent of responses
A	Verbal memory for names and definitions	2	5	7	5.5	5	3	10	0	18	5.4	25	5.4
B	Verbal memory for symbols and formulas	17	5	22	17.2	10	23	22	20	75	22.3	99	19.9
C	Verbal memory for laws and theories	2	2	4	3.1	3	0	4	6	13	3.8	17	3.7
D	Memory for laboratory work done	10	2	12	9.8	2	4	5	5	16	4.6	28	6.1
E	Memory for properties of substances, commercial uses, etc.	17	25	42	32.8	29	26	24	35	114	34.0	156	33.6
F	Memory for other facts	11	9	20	15.6	2	10	14	16	42	12.5	62	14.4
G	Equations to be written or completed	7	6	13	10.2	6	9	12	19	36	12.1	49	10.6
H	Thinking other than equations or computations	2	2	4	3.1	1	1	1	4	7	2.1	11	2.4
I	Computations	2	2	4	3.1	5	3	3	3	14	4.2	18	3.9
	Total	70	58	128	100.0	63	79	85	108	335	100.0	463	100.0

TABLE VI

SUMMATION OF RESPONSES UNDER MAJOR HEADS OF MENTAL ACTION

	All Examinations	
	Number of responses	Per cent of responses
Memory questions (Groups A to G inclusive)	434	93.3
Verbal-memory questions (Groups A, B, and C)	141	29.0
Possible habit questions (Groups G and I)	67	14.5
Possible thinking questions (Groups G, H, and I)	78	16.9

TABLE VII

ADJUSTED SUMMATION OF RESPONSES UNDER MAJOR HEADS OF MENTAL ACTION, DISTRIBUTING EQUATIONS AND COMPUTATIONS BETWEEN HABIT AND THINKING

	All Examinations	
	Number of responses	Per cent of responses
Memory	409	87.9
Thinking	36	7.2
Habit	19	4.9
	454	100.0

also a high grade of ability in English composition, for satisfactory answering. Only 8 such questions are found in the four Regents' examinations studied; 5 of these are on that of January, 1923. A non-tabulated survey of the examinations studied for the previous paper appears to indicate that substantially the same difference has existed as far back as 1916. This may be of considerable interest and usefulness; for it is evident that a pupil with ability of a high order in English composition will not be put at a disadvantage by taking the examinations set by the Board; on the other hand, a pupil good in chemistry but weak in composition is likely to show his attainment better on the Regents' examinations. Since the Regents' examinations are accepted (with reservations in some cases) for college entrance credit outside of New York state, it may prove advantageous to make wider use of them. The legitimacy of the requirement of English composition ability in a chemistry examination is hardly in point here; the existence of such a requirement, slightly in Regents' and strongly in Board examinations is all that is intended to be conveyed.*

* The writer has strong personal convictions that any such requirement as English composition or an overwhelmingly large proportion of memory-work in chemistry examinations is entirely illegitimate, as well as directly harmful in preventing chemical instruction from being directed towards its greatest usefulness to the pupils. His chemistry tests, reviewed some months ago in THIS JOURNAL, **2**, 622 (1925), are an attempt to measure the results of chemical instruction with as large an elimination of English composition and as small a proportion of memory-work as possible. Gerry and Powers have also gone far—at least equally far—in eliminating English composition ability in their chemistry tests; but they have probably exceeded the examinations in the proportion of memory-work required.

METHODS COURSES: SURVEY OF COURSES IN THE TEACHING OF CHEMISTRY

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Interest in a formal course in the teaching of chemistry is constantly increasing—among teachers, themselves, because of a desire to send out specially trained men and women, and among students because of a desire for better preparation for their new work. This interest has created a demand which is being met by comparatively few of our colleges, universities, or normal schools.

A preliminary examination was made, from the 1924–25 catalogs of two hundred seventy-five "Class A" colleges and universities[1] and two hundred normal schools and state teachers' colleges.[2] Communications were sent to the remainder of the colleges and normal schools listed, asking that either a catalog or a short description of the course be sent, provided "Chemistry Methods" was being offered. It can, therefore, be assumed that a complete survey has been made of all the listed schools.

Questionnaires were sent to all schools and colleges of the United States, which according to their catalog statements offer science methods courses (one hundred and fifty in all). The data compiled for this article are based on ninety-seven returned questionnaires.[3] Only seventy-one of these

[1] *Accredited Higher Institutions*, Bulletin number 30—Department of Interior, Bureau of Education.

[2] *Statistics of Teachers' Colleges and Normal Schools*, Bulletin number 8—Department of Interior, Bureau of Education.

[3] There is a course scheduled in chemistry methods (c) or science methods (s) in catalogs of the following institutions, but the information blanks have not, as yet, been returned.

Alabama, University of (c); Boston University (s); Capital University, Ohio (c); Carleton College, Minn. (c); Central Wesleyan, Mo. (s); Dakota Wesleyan University, S. D. (c); De Pauw University, Ind. (c); Florida State College for Women (c); Georgia, University of (s); Goucher College, Md. (c); Heidelberg University, Ohio (s); Indiana Central College (c); Indiana University (c); James Millikan University, Ill. (s); Judson College, Ala. (c); Kansas, University of (c); Knox College, Ill. (c); Leland Stanford Junior College (c); Louisville, University of, Ky. (c); Luther College, Iowa (s); Michigan, University of (c); Minnesota, University of (c); Muskingum College, Ohio (c); Notre Dame (s); Ohio Wesleyan (c); Pittsburgh, University of (c); Ripon College, Wis. (c); Saint Lawrence University, N. Y. (c); Saint Teresa, College of, Minn. (c); Southwestern College, Kans. (c); Sterling College, Kans. (c); Tarkia College, Mo. (c); Texas Christian University (c); Trinity College, Washington, D. C. (c); Wake Forest College, N. C. (c); Wilson College, Pa. (c); Wittenberg College, Ohio (s); Wooster, College of, Ohio (c).

Bridgewater State Normal, Mass. (s); Central Michigan Normal (c); East Carolina T. C. (s); Edinboro State Normal, Pa. (s); Northern Illinois State T. C. (s); Nebraska State Normal and T. C. (s); Northern Normal and Industrial School, S. D. (c); North Texas T. C. (c); Radford State T. C., Va. (s); Southeastern State T. C., Okla. (s); Southwestern Mo. T. C. (s); State Normal, Wis. (c).

schools are now offering courses in the teaching of chemistry or physical sciences including chemistry. Seven of the seventy-one are not actually giving the work this year. It should be stated, however, that the questionnaire was so worded that some schools offering methods courses in the physical sciences only, may not have replied, especially those in which the course is not offered by a member of the chemistry staff. Hence, the information concerning physical science methods courses is by no means complete. The number registered in the individual courses ranges from two to ninety-nine students. The prerequisites in chemistry vary from no work at all to sufficient to permit of graduate standing in the department. These courses include general, analytical, organic, and in a very few instances physical chemistry. The prerequisites in education vary from no work to thirty-six hours. This includes general and educational psychology and principles of education in the large majority of cases, and in several instances history of education and general methods. Only five schools are offering methods courses which are under the direction of men in the department of education. Four of the five classes are physical science courses; one is chemistry methods. Only a small number of schools (about seven) allow no credit for the methods course in the education department. From twenty to twenty-five per cent allow no credit toward a major or minor in chemistry.

In the following table the first column gives the name of the institution. The second and third columns indicate whether the course offered is in the teaching of chemistry or physical sciences. The next three columns indicate whether the work is being given either the first or second semester of 1925–26, or not at all, or in the summer session. In instances where the course is given every two or three years the schools have been credited as giving the work this year, if the number taking the course was stated on the information blank. The next three columns indicate whether the director of the course is a member of the chemistry, education, or science department. The latter includes natural and physical sciences, and physics departments. The last column gives the number of credit hours allowed for the course. One semester hour represents one hour of classroom work and two hours of preparation for one semester. All figures designate "semester hours" unless followed by a "q." This designates one "quarter hour" credit (3 quarters = 2 semesters).

A complete report at this time on the content of teachers' courses in chemistry, which are now being given, would be impossible from the data at hand. However, it may be of interest to summarize briefly from the few examination papers and outlines of courses which have been returned with the questionnaires.

Outstanding topics which are considered in various schools are:

1. A brief history of chemistry.

TABLE I

Name of institution	State	Nature of course		When offered			Course conducted by			Credit hours
		Teaching of chemistry	Teaching of sciences	1925–1926	Not in 1925–1926	Summer session	Department of chemistry	Department of education	Department of sciences	
Albion College	Mich.	x		x			x			4
Alma College	Mich.	x		x			x			2
Arkansas, University of	Ark.		x					x		2
Augusta College	Ill.	x				x	x			3
California, University of	Cal.		x	x					x	2
California, University of, Southern Br.	Cal.		x	x				x		2
California, University of, Southern Br.	Cal.	x				x	x			2
Carthage College	Ill.	x		x			x			1
Central College	Mo.		x			x		x		3
Chicago, University of	Ill.		x			x			x	2
Colgate University	N. Y.	x		x			x			6
Colorado State T. C.	Colo.	x		x			x			3
Colorado, University of[a]	Colo.	x				x	x			2
Columbia University T. C.	N. Y.	x		x		x			x	3
Converse College	S. C.	x			x		x			2
Defiance College	Ohio		x	x			x			2
Doane College	Nebr.	x			x		x			4
Earlham College	Ind.	x		x			x			2
East Tenn. State T. C.	Tenn.	x		x			x			1q
Franklin College	Ind.	x		x			x			1
Geneva College	Pa.	x		x			x			2
Gustavus Adolphus College	Minn.	x		x			x			1
Illinois, University of	Ill.	x		x		x	x			3
Illinois, Wesleyan University	Ill.	x		x			x			2
Kansas State T. C.	Kans.		x	x		x			x	2
Kansas State T. C.	Kans.	x		x					x	2
Keuka College	N. Y.		x	x			x			2
Lake Erie College	Ohio	x			x		x			2
Louisiana State University	La.	x			x		x			2
Maine, University of	Me.	x		x		x	x			2
Macalester College	Minn.	x		x			x			3
Marshall College	W. Va.		x			x	x			2
Maryland, University of	Md.	x		x		x	x			2
Mills College	Calif.	x			x		x			1
Milton College	Wis.	x			x		x			2
Milwaukee-Downer College	Wis.	x		x			x			1
Missouri, University of	Mo.	x		x			x			2
Mount Union College	Ohio	x		x			x			2
Nebraska, University of	Nebr.	x		x		x	x			2
North Dakota, University of	N. D.		x	x					x	6
North Dakota, University of	N. D.	x		–		–	x			4

[a] Two courses are offered—graduate and undergraduate. Same hours and credits for each.

Occidental College	Calif.	x		x			x		2
Ohio State University	Ohio	x		x			x		3q
Otterbein College	Ohio	x		x			x		4
Pacific, College of the	Calif.		x	x			x		2
Pacific University	Ore.	x		x			x		1
Peabody College for Teachers	Tenn.		x	x		x		x	5
Penn. State College	Pa.	x		x			x		3
Pomona College	Calif.	x		x			x		2
Purdue University	Ind.	x		x		x		x	2
Redlands, University of	Calif.	x			x		x		2
St. Elizabeth, College of	N. J.	x			x		x		2
St. Olaf College	Minn.	x		x			x		2
Southeast Mo. State T. C.	Mo.		x	x				x	2
Southwestern University	Texas	x		x			x		5
State College for Teachers	N. Y.	x		x		x	x		2
State College of Washington	Wash.	x		x			x		1
State T. C. of Nebraska	Nebr.	x		x		x	x		2
State T. C. Virginia	Va.	x		x				x	3q
State T. C. North Dakota	N. D.	x		–		–	–	–	–
State University of Iowa	Iowa	x				x	x		2
Syracuse University	N. Y.		x	x				x	2
Teachers' College	Ky.	x		x			x		6
Washington, University of	Wash.	x		x		x	x		2q
Wabash College	Ind.	x		x			x		2
Western College for Women	Ohio	x		x			x		2
Western State College	Colo.	x			x		x		4q
Whitman College	Wash.	x		x			x		2
Willamette University	Ore.	x		x			x		1–4
State Normal Schools									
Bowling Green State Normal College	Ohio		x	x				x	2
Fairmont	W. Va.	x		x			x		4
Illinois State Normal University	Ill.	x		x		x	x		5q
State Normal School	Wis.	x		x			x		2
Western State Normal	Mich.	x		x			x		4q

2. The use of the library.
3. Reasons for studying chemistry or science.
4. Application of general pedagogical methods to the teaching of chemistry.
5. Content of a high-school course.
6. Correlation of laboratory work and recitations.
7. Use of standardized tests.
8. Selection of texts.
9. Ordering and care of laboratory equipment, stock room service, etc.
10. Glass work—designing and making of laboratory apparatus.
11. Preparation of teacher, and how to keep in touch with up-to-date methods.

Sixteen schools have stated that practice teaching is included in their methods course. This teaching is usually done in a beginning chemistry class under the supervision of a member of the teaching staff. One professor goes so far as to say, "I do not know of any method for learning the teaching of chemistry except by experience under supervision."

The principal text-books used in chemistry methods courses are "Principles of Science Teaching," Twiss; "Teaching of Chemistry and Physics," Smith and Hall; "Science Teaching and the Science Teacher," Brownell and Wade; "Teaching of First Year Chemistry," Frank. Many of the courses seem to be conducted, without the use of a text, by giving considerable reference work.

I wish to thank all those who have aided in this undertaking by returning the questionnaires, sending copies of examination papers and outlines of their courses, and any other information. Particular thanks are due to Dr. R. A. Baker of Syracuse University, for his interest and helpful suggestions.

Many Metals Found in Cotton Plant. The cotton plant is a veritable mineral mine, under the hands of a chemist, according to Dr. J. S. McHargue of the Kentucky Agricultural Experiment Station, who addressed the American Chemical Society at its Tulsa Meeting. In addition to iron, phosphorus, magnesium, calcium, potassium, and sodium, metallic elements commonly found in plants and considered essential parts of them, Dr. McHargue found copper, manganese, and zinc. He found the copper and zinc in greatest concentration in the kernel of the cotton seed, and suggests that these elements play a vital part, as yet unknown, in the economy of the plant.—*Science Service*

Cooking Not Harmful to Vegetable Vitamins. The idea held by many people that vitamins in vegetables are harmed by cooking was attacked by E. F. Kohman of Washington, D. C., speaking before the American Chemical Society at Tulsa. Vitamin C, the one which prevents scurvy, has been most commonly supposed to be injured by cooking, but vitamin A, which insures normal growth, has also been included in the list, Mr. Kohman told his hearers. The damage was supposed to result from the combination of the vitamin with oxygen from the air at the high temperatures of cooking, but in tests which he conducted Mr. Kohman was unable to confirm these suppositions.

"The only experimental evidence in the literature that vitamin A is destroyed by oxidation is in connection with fats when they are directly exposed to air in shallow layers while being heated," said Mr. Kohman. "This condition is scarcely ever met with in the handling of foods. There is an abundance of evidence that vitamin A is not destroyed by oxidation in the general handling of foods. Live steam has been passed through butter fat for 6 hours with no loss of vitamin A. Steenbock and Boutwell heated yellow maize, chard, carrots, sweet potatoes, squash, and alfalfa under pressure for three hours at 248 degrees Fahrenheit, with no loss of vitamin A being evident. This is a more severe temperature than any canned foods are ever subjected to. We have doubled the process of canned peas from 25 to 50 minutes at the same temperature without any loss of vitamin A being made evident under either condition. It is possible that vitamin A might be destroyed under these conditions of heating foods if oxygen were actually bubbled through them. But within the conditions of handling foods it may safely be stated that vitamin A is not oxidized."—*Science Service*

QUESTIONNAIRE STUDY OF THE DUTIES OF THE ONE IN CHARGE OF THE DEPARTMENT OF SCIENCE WITH PARTICULAR REFERENCE TO CHEMISTRY

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Many of our secondary schools offer chemistry.[1] In the smaller schools the teacher of chemistry may also be teaching other sciences or, as is often the case, non-science subjects. In the larger schools enough chemistry may be given to require the full time of one teacher or several teachers. The question often arises in a particular situation how shall the chemistry in this school be organized, relative to the other sciences offered and what shall be the duties of the one placed in charge of the department?

In practice there seem to be three well-defined ways of organization as indicated by a recent study.[2] The chemistry may be organized into a department separate and distinct from the other sciences, with one of the teachers designated as head, who in addition to his teaching has certain duties and responsibilities not expected of the other teachers in the department. With physics it may be organized into the department of physical science. As one of the several sciences offered it may be organized as a part of the science department with the one head responsible for all. The enrolments of the schools covered in this investigation ranged from approximately 100 to over 8000. The largest number of schools were organized with all the science under one head. Practically all the very large schools were organized with a head for each branch of science. While there were many exceptions, the type of organization varied with the size of the school.

The job of the one in charge of the department of science, or sub-division of science seemed to vary greatly as to responsibility and authority. In answer to the question "What authority and responsibility is vested in the head of department?" the range from none to entire was given.

What then should be the duties of the one in charge of the department of science or sub-division of science? Should his duties be administrative, supervisory, or both? Which of his duties are the most important? Is the time required for the performance of the different tasks large enough that his teaching load should be decreased? In the larger schools should he be expected to teach any classes? What relation will he bear to the principal of the school; to the teachers working with him in the depart-

[1] Of the 13,700 high schools reporting statistics to the U. S. Bureau of Education for the years 1920–22, 4291 report that they offer chemistry.

Statistics of Public High Schools, 1920–22, *Bull.*, **1924**, No. 7, p. 56. United States Bureau of Education, Department of the Interior.

[2] Carpenter, Weston W., "Certain Phases of the Administration of High-School Chemistry," chapter 2. Teachers' College Contribution to Education No. 191, Bureau of Publications, Teachers' College, Columbia University, New York City, 1925.

ment? Should he be held responsible for the selection of text-books; for the adjustment of courses to the needs of the community and individual? Should special training be required of a teacher before he is appointed as head of a department or should years of service be his only qualification?

In order to find practical answers to a few of these questions, a collection of such duties as heads of science departments do perform or should perform was made by the students of Professor S. R. Powers of Teachers' College, Columbia University. Additional duties were taken from the valuable study of Professor Abbott[3] on "The Special Function of the Head of the Department of English." From all of the duties suggested fifty were selected, which seemed, as nearly as possible, to be mutually exclusive and to represent the range of the selected duties.

The following questionnaire was then prepared:

DUTIES OF HEADS OF HIGH-SCHOOL DEPARTMENTS OF SCIENCE UNDER IDEAL CONDITIONS OF TIME AND ADMINISTRATIVE SUPPORT

The following are possible duties of heads of high-school departments of science or sub-divisions of science. Read the entire list through before you rank any of the duties. On the sheet shown on page 536 the left-hand side of the paper is divided into three parts. Place the numbers of the duties which you consider to be most important in the top square, the least important in the middle square and all the others in the bottom square. Apportion them approximately equally. After you have done this re-rank each large division in the same way using the nine small spaces on the right hand side of the page. Make the frequency in each of the nine squares approximately equal. In case you locate duties which in your estimation are not proper duties for a head of high-school science, draw a circle around such duties.

1. Extensive readings in general and special fields.
2. Attend local, state, and national conferences.
3. Visit other schools.
4. Continue university study.
5. Teach some class regularly.
6. Support the policies of the principal and interpret them to the department.
7. Keep the principal informed as to the progress and needs of the department.
8. Prepare a budget for needed equipment and supplies for all divisions of science.
9. Determine the desirability, utility, and ultimate cost of equipment and supplies.
10. Be responsible that broken equipment is repaired and worthless equipment is disposed of.
11. Develop efficient methods of distributing equipment and supplies.
12. Evolve a permanent inventory of all equipment and supplies so as to be most convenient for periodical checking and budget making.
13. Be responsible for a systematic inspection of all permanent equipment.
14. Be responsible for receipting for equipment and supplies on delivery.
15. Be responsible for the storage of equipment and supplies.

[3] Abbott, Allan, "The Special Function of the Head of the Department of English," *English J.*, **2**, 272–82 (1922).

16. Be responsible for the store room and material therein stored.
17. Be responsible for checking incoming material against the order: O. K.-ing all science bills before they are sent to higher authority for payment.
18. Keep all necessary records.
19. Check orders for text-books.
20. Advise with students about their science work.
21. Interview parents.
22. Recommend teachers for appointment.
23. Recommend teachers for assignment to classes.
24. Recommend teachers for promotion.
25. Adjust the science courses to the lower grades.
26. Adjust the science courses to college.
27. Adjust the science courses to other departments.
28. Adjust science courses to state, county, or city syllabus.
29. Adjust the science courses to the individual differences of the pupils.
30. Adjust the science courses to community needs and resources.
31. Handle minor cases of discipline peculiar to the department.
32. Arrange extra class activities.
33. Formulate with the teaching staff a definite program based on a clear conception of the purposes of the department.
34. Supervise the selection of texts and the organization of courses.
35. Assist in determining the minimum essentials.

Develop the individual ability and encourage professional growth of the teachers in the department by.....

36. Departmental meetings and discussions.
37. Committee discussions of policies and procedures.
38. Professional reading and study.
39. Encouraging experimentation.
40. Giving each the work that he can do best.
41. Allowing much individual freedom in the organization of work.
42. Giving publicity to notable work.
43. Recommendation of teachers for better positions in other schools.

Improve instruction by direct supervision by.....

44. Purposeful and systematic observation of teaching.
45. Conferences following observation.
46. Demonstrations, inter-class visits, inter-school visits, etc.
47. Test the results of supervision by the use of standard tests.
48. Foster community growth through particular contributions of special subjects.
49. Furnish publicity for school activities and school policies.
50. Act as a member of a school cabinet or council to formulate policies for the entire school.

Administrators, heads of science departments, students of education, and class-room teachers might not entirely agree as to what they considered a proper duty for a head of a science department. Therefore questionnaires were submitted to representatives of all of these groups in order that the results might represent the opinions of those interested. Seventy-two persons coöperated in this study by sending in information and fifty-seven of these made the rankings requested.[4]

[4] See footnote 2, Chapter 3, Teachers' College Contribution to Education No. 191.

School.....City.....State.....Name.....Position.....

First Grouping	Second Grouping
In this space place the numbers of the duties you think most important. Division A.	In this space place the numbers of the duties you think most important (use only the numbers assigned to division A).
	Least important of division A.
	All members of division A not placed above.
In this space place the numbers of the duties you think least important. Division B.	Most important of division B.
	Least important of division B.
	All numbers of division B not placed above.
In this space place the numbers of the duties not placed above. Division C.	Most important of division C.
	Least important of division C.
	All numbers of division C not placed above.

The judgments on the importance of the various duties were then tabulated and from the weightings given, index numbers were calculated and an index number assigned to each proposed duty. The relative size of the index numbers indicates how this selected group classified the different duties. If all fifty-seven had circled a given duty, the index number would have been zero. If all fifty-seven had placed the same duty in the lowest class, the index number would have been one. If all fifty-seven had placed the same duty in the highest class the index number would have been nine. All fifty of the suggested duties received index numbers which vary in size from 2.77 to 7.63. This indicates first, that the duties selected are duties such as competent judges would expect heads of departments to perform, and second that these judges agree fairly well among themselves as to the relative importance of these duties.

Using Peterson's method of ranking,[5] the index numbers were converted into ranks, the highest index ranking one and the lowest fifty. With the aid of Haught's table these ranks were then converted into percentile scores.[6]

Five of the seven largest scores were for supervisory duties and two were for administrative relationships with the principal. When the duties that were considered as administrative or supervisory were classified into those groups and the mean percentile score of each group calculated, a score of 59.12 was obtained for the supervisory group and a score of 44.57 for the administrative group. This would indicate that a supervisory duty, on the whole, was considered to be more important than an administrative duty. There are, however, more of the administrative duties.

In the list that follows, the duties were arranged in the following groups, (1) Personal (for professional growth), (2) Administrative, (3) Supervisory, (4) Community. The order of these main divisions was arbitrarily determined by using the same order as used by Professor Powers when he presented this subject to one of his classes in Teachers' College, Columbia University. The sub-groups under each main group were then placed in the order determined by the sum of the percentile scores for that sub-group. The duties under each sub-group were arranged in the order of their percentile scores.

Duties of the One in Charge of the Department of Science

I. Personal duties. (For professional growth.)

1. Teach some class regularly.

[5] Peterson, Joseph, "A Simple and Accurate Method of Ranking," *Peabody J. Educ.*, **1**, 39–43 (1923).

[6] Haught, B. F., "A Scheme for Combining Incomplete Rankings," *J. Appl. Psychol.* **7**, 168–72 (1923).

TABLE I

INDEX NUMBER, RANK, AND PERCENTILE SCORE FOR EACH ONE OF THE FIFTY DUTIES

Number of duty	Index number	Rank	Percentile score
1	5.79	12	62
2	5.65	15½	58½
3	4.68	28	48
4	5.67	14	60
5	6.74	8	67
6	7.63	1	91
7	7.21	4	75
8	6.37	11	64
9	4.77	25	51
10	3.00	47	25
11	4.53	30	46
12	4.12	35	42
13	3.11	46	28
14	3.21	43	33
15	2.79	49	18
16	2.81	48	22
17	4.04	36	41
18	3.79	38	39
19	3.60	40	36
20	6.53	10	65
21	3.79	38	39
22	4.72	26½	49
23	5.12	19½	55½
24	4.98	22	53
25	4.23	34	43
26	4.40	31	45
27	5.00	21	54
28	4.37	32	44
29	5.63	17	57
30	5.65	15½	58½
31	3.14	45	30
32	3.79	38	39
33	6.77	6½	69½
34	7.60	2	82
35	6.63	9	66
36	7.16	5	72
37	4.72	26½	49
38	4.28	33	43
39	5.12	19½	55½
40	5.32	18	57
41	4.89	24	51
42	3.19	44	31
43	2.77	50	9
44	7.28	3	78
45	6.77	6½	69½

46	4.63	29	47
47	4.95	23	52
48	3.44	41	35
49	3.40	42	34
50	5.77	13	61

2. Extensive readings in general and special fields.
3. Continued university study.
4. Attend local, state, and national conferences.
5. Visit other schools.

II. Administrative duties.

1. Responsibility for equipment and supplies.
   (*a*) Prepare a budget for needed equipment and supplies.
   (*b*) Determine the desirability, utility, and ultimate cost of equipment and supplies.
   (*c*) Develop efficient methods of distribution of equipment and supplies.
   (*d*) Evolve a permanent inventory of all equipment and supplies so as to be most convenient for periodic checking and budget making.
   (*e*) Responsible for checking incoming material against the order, O. K.-ing all science bills before they are sent to higher authority for payment.
   (*f*) Keep all necessary records.
   (*g*) Check orders for text-books.
   (*h*) Responsible for receipting for supplies and equipment on delivery.
   (*i*) Responsible for a systematic inspection of all permanent equipment.
   (*j*) Responsible that broken equipment is repaired and worthless equipment is disposed of.
   (*k*) Responsible for the storerooms and the material therein stored.
   (*l*) Responsible for the storage of equipment and supplies.

2. Adjustment of the science courses; to:
   (*a*) The community needs and resources.
   (*b*) The individual differences of the pupils.
   (*c*) Other departments.
   (*d*) College.
   (*e*) State, county, or city syllabus.
   (*f*) The lower grades.

3. Responsibility to the authorities of the school.
   (*a*) Support the policies of the principal and interpret them to the department.
   (*b*) Keep the principal informed as to the progress and needs of the department.
   (*c*) Act as a member of the school cabinet or council, to formulate policies for the entire school.
4. Relation to the teachers in the department; to recommend teachers for:
   (*a*) Assignment to classes.
   (*b*) Promotion.
   (*c*) Appointment.
   (*d*) Better positions in other schools.
5. Interview parents.
6. Arrange extra class activities.
7. Handle minor cases of discipline peculiar to the department.

III. Supervisory duties.

1. Develop the individual ability and professional growth of the teachers in the department, by:
   (*a*) Departmental meetings and discussions.
   (*b*) Giving each the work that he can do best.
   (*c*) Encouraging experimentation.
   (*d*) Allowing much individual freedom in the organization of work.
   (*e*) Committee discussions of policies and procedures.
   (*f*) Professional reading and study.
   (*g*) Publicity for notable work.
2. Improve instruction by direct supervision, by:
   (*a*) Purposeful and systematic observation of teaching.
   (*b*) Conferences following observation.
   (*c*) Demonstrations, inter-class visits, inter-school visits.
3. Supervise the selection of tests and the organization of courses.
4. Formulate with the teaching staff a definite program based on a clear conception of the purposes of the department.
5. Assist in determining the minimum essentials.
6. Advise with students about their science work.
7. Test the results of supervision by the use of standard tests.

IV. Community duties.

1. Foster community growth through particular contributions to special subjects.
2. Furnish publicity for school activities and school policies.

Many of the schools having heads for science departments have not recognized the importance of the position. In a recent article, Franklin W. Johnson[7] of Teachers' College, Columbia University says: "The schools are becoming too large and too complicated in their organization for the principal, even though he were sufficiently expert, to handle alone the work of administration and supervision. The departmental heads are in a position to relieve him of many duties of administration and give the expert and detailed supervision for which he usually has neither the time nor the training."

We shall expect better teaching of science as the heads of the departments understand definitely what is expected of them relative to supervision and administration, assuming that the principal will definitely delegate duties and hold heads of departments responsible for results.

[7] Johnson, Franklin W., "The Departmental Head," *Sch. Rev.*, **33**, 523–31 (1925).

Substitute for Quinine Is Sought. The monopoly of the quinine market held by the Netherlands must be broken, say the health experts of the League of Nations. At present the most effective remedy against malaria is quinine made from the cinchona bark grown in the Dutch East Indies, which furnish nine-tenths of the world's supply. Cinchona bark from the other countries which supply the remaining tenth gives only 2 to 5 per cent quinine while that from Java, the principal source, runs 5 to 7 per cent.

The production of quinine in the Netherlands possessions is in the hands of a syndicate which fixes the price on the Amsterdam market. A return of 36 per cent is paid on the capital invested. There is an independent Japanese company but the competition that it affords is not for the present appreciable. Requests for the government to regulate the actions of the "quinine ring" have met with the reply that the quinine interests are merely safeguarding the legitimate rights of the industry.

The health officials of the League are concentrating their attention on the development of a suitable substitute for quinine. Cinchonine, a drug made from a combination of several cinchona barks from trees growing elsewhere than in the East Indies, is under consideration as such a substitute. If it is found that it can be made as efficient as quinine, an effort to break the monopoly will be made by encouraging the cultivation of cinchona trees in all parts of the world where they will grow.—*Science Service*

Some Vitamins Increased in Milk, Some Destroyed by Sun's Rays. Vitamin D, the substance in milk that prevents rickets, a disease of the bones, is increased when the milk is exposed to ultra-violet light, invisible rays given off by the sun and some mercury vapor arc lamps. However, it is not likely that dairies will begin to use ultra-violet light on their products, for vitamin A, the substance that insures normal growth, is destroyed by the same process. Prof. J. S. Hughes, of the Kansas State Agricultural College, told members of the American Chemical Society at Tulsa of his work in collaboration with R. W. Titus and J. B. Fitch on this subject.

In their experiments one set of chicks was fed with milk that had been exposed to ultra-violet light, while a second group was fed with untreated milk. The latter developed normally but the first group developed conditions typical of the lack of vitamin A, Prof. Hughes stated.—*Science Service*

A SIMPLE RULE FOR THE CLASSIFICATION OF THE ELEMENTS

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Most of the schemes for classifying the elements are based on Mendelejeff's Periodic Law or some modification of it. The advantages of these systems are discussed in text-books and are well-known. In order to benefit by these advantages, however, the average chemist must have his table ready-made because of the difficulties in making one, which are as follows: (*a*) The periods are of different lengths and so the properties are *not* periodic functions of the atomic weights. (*b*) The weights reverse the positions of argon and potassium, cobalt and nickel, and tellurium and iodine. (*c*) Each group contains two families into which the elements can be placed only by a knowledge of their properties. The second defect is removed by the use of atomic numbers instead of the weights, but the first and third persist. For these reasons the present paper proposes a scheme which may be used to place the elements in the usual classes without recourse to any properties except the atomic numbers. It is, therefore, of maximum service in learning or using the chemistry of the less known members of the families.

The Basis of Classification

The present classification is made from the atomic numbers, that is, the number of electrons outside the nucleus of the various atoms. Furthermore, the arrangement of these electrons is taken to be in layers which require, passing from the nucleus outward, 2, 8, 8, 18, 18, 32, and 32 electrons, respectively, for saturation.[1] The assumption is now made that the chemical nature of an element is determined by the number of electrons in the outer layer or rather by the state of saturation of that layer. The first case is that of complete saturation, represented in the first layer by the element with 2 orbitular electrons (He); in the second layer by the element with 2 + 8 (Ne); in the third by that with 2 + 8 + 8 (A); and so on. These, having the outer layer saturated, show no tendency to lose electrons, and likewise, none to gain them in a layer which contains no electrons in the neutral atom. These elements, therefore, are inactive chemically.

The second case is that of those elements which have one electron in the outer layer, that is, H(1), Li (2 + 1), Na (2 + 8 + 1) and so on. In this case the tendency of the element is to lose its one outside electron and become positive, with a valence of one in combination.

In the cases which follow there will be, for example, in every layer except the first, the elements with two, three, four, five, six, and seven electrons, and so we might expect a positive valence of two, three, four, five, six,

[1] Langmuir, *J. Am. Chem. Soc.*, **41**, 868 (1919).

and seven, respectively. This in most cases does, of course, exist. However, as the layer approaches saturation there is an increasing tendency to gain enough electrons to saturate it completely. For example, the element having seven electrons in the second layer (F) is characterized by the strong negative valence of one. Between those elements whose outer layers contain one electron and those which lack one for complete saturation, there are several elements whose properties are in some instances determined by the number of electrons present in the outer layer and in other instances are determined by the number of electrons lacking for complete saturation of that layer.

These principles are made the basis of the present classification. In the case in which the second layer is the outer one, there are the following elements:

Symbol	Li	Be	B	C	N	O	F	Ne
At. No.	3	4	5	6	7	8	9	10
Electrons in outer layer	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*n*

These elements may be placed in families either because of the outer electrons present which are *1, 2, 3, 4, 5, 6, 7,* or *n;* or because of those which are lacking which are the same in the reverse order and so are represented by *n-7, n-6, n-5, n-4, n-3, n-2,* and *n-1,* where *n* is the number of electrons required to saturate the layer, in this case, eight. This makes a decision necessary since any element may fall into either of two families (except the inert gases which all fall in the *n* family). That is, carbon might be in the *4* group or in the *n-4* group, nitrogen in the *5* or the *n-3* group and so on. For the purpose of this decision the following arbitrary rule is the most useful: *If the number of electrons in the outer layer is less than forty per cent of the number required for saturation, the element belongs in the direct family* (*1, 2, 3, etc.*), *if more than forty per cent, in the indirect family* (*n-7, n-6, n-5, etc.*). This rule covers fifteen families and includes all of the elements which involve the first three and the seventh as outer layers and most of those whose valence electrons are in the fourth, fifth, and sixth layers.

The rule is very simply applied. Take, for example, aluminum which has three electrons in the third or outer layer (Table I). Since this layer requires eight electrons for saturation and three is less than 40 per cent of eight, aluminum belongs in the *3* family, while silicon which contains more than 40 per cent of eight electrons in the outer layer belongs in the *n-4* family. In Table I, those elements which cannot be placed in the above families are inclosed in braces.

The fifteen families so far mentioned do not include all of the elements whose outer electrons are beyond the third layer. In the fourth layer, the *7* group takes manganese and the *n-7*, copper, which leaves nickel, cobalt, and iron that do not fall into the above families. Since the number of

TABLE I

THE ATOMIC NUMBERS OF THE ELEMENTS AND THE NUMBER OF ELECTRONS IN THE OUTER LAYERS

Symbol	Atomic no.	Outer electrons
First layer		
H	1	1
He	2	*n*
Second layer		
Li	3	1
Be	4	2
B	5	3
C	6	4
N	7	5
O	8	6
F	9	7
Ne	10	*n*
Third layer		
Na	11	1
Mg	12	2
Al	13	3
Si	14	4
P	15	5
S	16	6
Cl	17	7
A	18	*n*

Symbol	Atomic no.	Outer electrons
Fourth layer		
K	19	1
Ca	20	2
Sc	21	3
Ti	22	4
V	23	5
Cr	24	6
Mn	25	7
Fe	26	8
Co	27	9
Ni	28	10
Cu	29	11
Zn	30	12
Ga	31	13
Ge	32	14
As	33	15
Se	34	16
Br	35	17
Kr	36	*n*

Symbol	Atomic no.	Outer electrons
Fifth layer		
Rb	37	1
Sr	38	2
Yt	39	3
Zr	40	4
Cb	41	5
Mo	42	6
	43	7
Ru	44	8
Rh	45	9
Pd	46	10
Ag	47	11
Cd	48	12
In	49	13
Sn	50	14
Sb	51	15
Te	52	16
I	53	17
Xe	54	n
Seventh layer		
	87	1
Ra	88	2
Ac	89	3
Th	90	4
U-X_2	91	5
U	92	6

Symbol	Atomic no.	Outer electrons
Sixth layer		
Cs	55	1
Ba	56	2
La	57	3
Ce	58	4
Pr	59	5
Nd	60	6
	61	7
Sa	62	8
Eu	63	9
Gd	64	10
Tb	65	11
Dy	66	12
Ho	67	13
Er	68	14
Tm	69	15
Yb	70	16
Lu	71	17
Hf	72	18
Ta	73	19
W	74	20
	75	21
Os	76	22
Ir	77	23
Pt	78	24
Au	79	25
Hg	80	26
Tl	81	27
Pb	82	28
Bi	83	29
Po	84	30
	85	31
Rn	86	*n*

electrons in the outer layer is greater than 40 per cent of 18, these elements must fall into "indirect" families and so the list is extended to *n-8*, *n-9*, and *n-10*. These families have no members involving only the first three layers because here these values would be zero or negative. This extension provides for all the elements except those whose atomic numbers lie between 61 and 76. In other words all of the ninety-two elements except fourteen are classified in families as shown in Table II.

TABLE II

THE FAMILIES OF CHEMICAL ELEMENTS

			1	*2*	*3*	*4*	*5*	*6*	*7*	
			Li	Be	B					
			Na	Mg	Al					
			K	Ca	Sc	Ti	V	Cr	Mn	
			Rb	Sr	Yt	Zr	Cb	Mo	..	
			Cs	Ba	La	Ce	Pr	Nd	..	
			..	Ra	Ac	Th	$U\text{-}X_2$	U		
n-10	*n-9*	*n-8*	*n-7*	*n-6*	*n-5*	*n-4*	*n-3*	*n-2*	*n-1*	*n*
									H	He
						C	N	O	F	Ne
						Si	P	S	Cl	A
Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	..	Rn

Discussion

In this classification there are some of the usual difficulties. There are, however, no more than are common to all such tables. The disposition of all the elements common to both tables corresponds to that of Lewis[2] with the exception of carbon and silicon which he places with titanium and zirconium.

The advantage of the table lies in the fact that any of these seventy-eight elements may be placed in its proper family from its atomic number. For example, molybdenum has the atomic number 42. Of these 42 electrons, 2 are in the first layer, 8 in the second, 8 in the third, and 18 in the fourth which leaves 6 in the fifth. Since 6 is less than 40 per cent of the 18 required to saturate this layer, the element belongs in the "direct" families and, therefore, in the *6* family. Likewise the atomic number of indium is 49 and by the same calculation we find 13 electrons in the fifth or outer layer. This is more than 40 per cent of 18 and so the element belongs in the "indirect" *n-5* family.

The fourteen elements not included in Table II are Sa, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu, Hf, Ta, W, and Ma. These are mainly the rare earths whose disposition in tables of this kind is only tentative. Since the first of these has eight electrons in a layer requiring thirty-two for saturation and the last lacks twelve of completing that number, it is scarcely to be expected that the tendency to gain or lose a definite number of electrons can be predicted. However, some of these can be pretty well placed by extending the "indirect" families. Thus *n-11* is masurium, *n-12* is tungsten, *n-13* tantalum, *n-14* hafnium, *n-15* lutecium, *n-16* ytterbium, and *n-17* thulium. If these elements be placed in Table II where

[2] Lewis, "Valence and the Structure of Atoms and Molecules," Chemical Catalog Co., New York, 1923.

these values would fall in the fourth and fifth layers, they fall into the *7*, *6*, *5*, *4*, *3*, *2*, and *1* families, respectively. This violates the 40 per cent rule in the fourth and fifth layers but not in the sixth where these elements lie. They are fairly well fitted to those families by their properties, although ytterbium becomes an alkaline earth and thulium an alkali metal which is unlikely although they have been so classified.[3]

Samarium, the first of these unassigned elements contains eight electrons in the sixth layer. If this were placed with those in the fourth and fifth layers having the same number, it would come in the *n-10* or iron family, europium with cobalt, gadolinium with nickel, terbium with copper, dysprosium with zinc, holmium with gallium, and erbium with tin. While this extension of the rule finds little theoretical justification, there is some similarity of properties, especially in the earlier members. This arrangement of the rare earths is at best merely a suggestion since their properties show them to be more nearly related to each other than to the other families. The state of saturation of the outer layers in these elements is such that they have no exact counterparts among the elements of lower atomic number.

Summary

A rule is given whereby all of the elements except the rare earths can be placed in the proper chemical families by means of the atomic number and the number of electrons required to saturate each layer as given by Langmuir.

[3] Mellor, "A Comprehensive Treatise of Inorganic and Theoretical Chemistry," Volume **V**, p. 617 (1924).

Pan-Pacific Science Congress to Be Held in Tokyo This Fall. Scientists of all the nations bordering the Pacific Ocean will meet at Tokyo this fall, in response to an invitation from the Japanese National Research Council. The sessions will be held from October 27th to November 9th, to discuss problems of common interest to all of them, rising from the conditions of the sea and the weather that prevail over it, from the plant and animal life that swims in the water, and from the changes in that part of the crust of the earth that makes up its bottom and its shores. This will be the third Pan-Pacific Science Congress, the two previous meetings having been held in Hawaii and in Australia. A number of American scientists have already signified their intention of attending and others are expected to join the conference later.—*Science Service*

U. S. Declared Leader in Three Sciences. The United States leads the world in the outstanding value of research done in biology, geology, and astronomy, according to Dr. J. McKeen Cattell, editor of *Science*. We are outclassed by Great Britain and Germany when it comes to physics, chemistry, and physiology, but are on about even terms with respect to mathematics and medicine, he believes. With regard to psychology there is room for question. More experimental work is carried on here than in any other country and not only has the number of psychological workers doubled since before the World War, but Dr. Cattell believes the work is of high quality.—*Science Service*

SEPARATION WITH PHASE CHANGE: DRYERS AND DRYING*

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In the short time allotted for a subject of this nature, it would be impossible to give anything but a brief reference to various phases of drying problems. That part with which I will have to do, will be more particularly that applying to industrial practice not only in the chemical but other industries as well, since practically every industry bears some relation to the chemical industry. For more specific theoretical data on this subject, I refer you to pages 619–625, 1923 edition of "Kent's Mechanical Handbook." In practical application, the only safe course to pursue is to consult companies that specialize in drying equipment. Trade papers and equipment catalogs list these companies.

Dryers are used primarily to facilitate further handling of materials, to reduce grinding and shipping costs, to prevent possible ruin and increase in repairs to supplementary equipment, to aid in mixing and to allow for more rapid and less expensive calcining or burning.

While a dryer is an apparatus for driving off free moisture from materials, it does so by the application of heat or by air absorption, and is thus distinct from a dehydrator which extracts moisture by mechanical means, and from a calciner which drives off the combined moisture and other volatiles usually by roasting at high temperatures.

The more common problems of drying have to do with the drying of nonmetallic minerals, as for instance, the drying of coal before pulverizing in cement plants; sand and stone for use as a mix with hot asphalt in paving plants; phosphate rock before grinding in fertilizer plants; clays in plants producing for the china, paint, and rubber industries; Fuller's earth in the oil-refining industries; gypsum in the plaster manufacturing plants; and salts, coke, and chemicals in chemical works.

Let us take a concrete example: The use of dryers in cement plants.

While a cement plant cannot be termed a chemical industry, chemistry is finding a greater application in this field, and the chemical engineer has become a part of every up-to-date cement organization. For this reason it would be well to consider phase change of the raw materials entering into the process of cement manufacture and thus study dryers and drying in this one industry.

Drying problems in this industry comprise raw material dryers—these only in dry process plants; and coal dryers—these only in plants using coal as fuel in kiln.

The raw material consists of stone, shale, and clay. Quantities vary according to the size plant. For instance—a 3600-barrel plant requires from 50 to 55 tons per hour of the raw mix in which case a rotary dryer

* Student lecture delivered at the Tenth Exposition of Chemical Industries, New York City, October 1, 1925.

7′ 6″ diam. × 75′ 0″ long would give a hot and dry stone when drying from 6% moisture. The cost of this machine installed would run from $15,000.00 to $20,000.00 depending on the type of construction used and local conditions.

The coal, which is pulverized for use in the rotary kilns in burning the raw mix slurry into clinker, is dried prior to grinding. Because of the unusual conditions involved in the drying of a combustible material of this character, the most careful consideration of details of construction of a dryer for coal is necessary.

The most common type of dryer used for this purpose is the double shell dryer, about which information will be given further on.

A 3600-bbl. cement plant, dry process, requires approximately 8 tons per hour of coal for kiln and coal dryer requirements. A double shell dryer 5′ diam. × 30′ long would fill the requirements when drying from 10% moisture. Such a dryer installed would cost approximately $7000.00.

As previously stated, drying is accomplished by driving off free moisture by the application of heat or by air absorption. There are two forms or methods of drying by mechanical means: *direct heat* and *indirect heat.* These may be classified according to the type dryer used, as follows:

Direct heat	Indirect heat
Direct fired rotary dryer.	Indirect rotary dryer (steam)
Semi-direct fired rotary dryer.	Indirect fired rotary dryer (with combustion gases)
Direct fired stationary dryer, (Vertical or tower type)	Indirect rotary dryer (steam-drum or vacuum type)
	Indirect dryer (steam—pan or tray type)
	Indirect dryer (steam—tunnel or conveyor type)
	Indirect dryer (steam or combustion gases—paddle or screw type)

By *direct heat* drying is meant the application of heat from gases of combustion directly on the material being dried, an instance of this being in the drying of some clays in a rotary single shell dryer, the heat for drying being generated in a Dutch oven furnace and drawn through the cascading material passing through the dryer shell. A fan or stack is placed at the opposite end of the furnace for removing the moisture and drawing gases through the material.

A modification of this form of drying with a resultant increase in thermal efficiency of about 20 to 25% was brought about by Mr. Wm. B. Ruggles some thirty years ago, and has since been elaborated on in the production of the double-shell rotary dryer. In this type of dryer, known as the semi-direct heat or two-pass dryer, the heat is first drawn through the inner shell and returned through the showering material in the annular space between the inner and outer shell. By such a method the heat is used at

the higher temperatures by radiation and at the lower temperatures by direct contact with the returning gases of combustion. The increase in thermal efficiency, literally meaning decrease in fuel required per unit of product dried, is brought about by this utilization of the gases "going and coming," so to speak. The material is fed at the high or furnace end of the shell and discharged at the opposite or low end.

By *indirect heat* drying is meant the drying by heat produced indirectly from the gases of combustion, as for instance, steam generated at a boiler and transported through pipes or coils producing the heated air necessary for drying by passage over or through the material being dried. An instance of this is found in the drying of tobacco stems in a rotary steam dryer having return bend pipe coils on the interior of the shell, steam being supplied through a rotary steam valve at one end. As the moisture is liberated, it is drawn off by a fan or stack placed at one end of the dryer shell. The material, being fed at one end, is showered through the heated air passing through the shell and is discharged at the opposite end.

Another form of indirect heat drying consists in the passing of hot combustion gases through an inner shell of a double shell dryer similar to the semi-direct type, and returning them through ducts. The air in the drying chamber between the two shells is heated by radiation from the inner shell and ducts and thus the products being dried are not contaminated by products of combustion. Drying is accomplished by radiation and contact with heated air, not gases.

In the indirect rotary drum dryer, the steam is supplied to the interior of the drum, thus heating the whole surface of the drum. The drum, revolving at slow speed in a pan containing the wet material, takes up the material in a thin layer, drying in one rotation. The material is discharged with the aid of a scraper on the downward side of rotation. The action is similar to that of the rotary continuous filter press. This dryer must not be mistaken for the commonly known rotary dryer, and is used only where the material is in a liquid state and primarily for pasty materials.

In the other forms of indirect heat dryers, such as the pan or tray and tunnel dryers, the material is placed in pans either on trucks or conveyors and remains in a heated air chamber for the required length of time to dry the material. These are used extensively in the chemical industry, and their greatest field is doubtless in the drying of finely divided and sticky materials that usually involve mechanical difficulties when using the rotary dryer.

It has been my purpose to convey to your minds an impression of the outstanding features of the various types of dryers and how they are applied to different problems. It is to be hoped, however, you will consider these descriptions only as a basis for your calculations when confronted with a problem in drying, as nearly all the types described can be arranged

differently and thus produce an entirely different effect. For instance, in the ordinary single shell dryer some materials require drying with the furnace at the feed end, thus giving a parallel flow dryer as distinguished from the counter-flow more commonly used. Some materials are more successfully handled in a dryer using a stack in place of the fan for carrying off the moisture. Then too, while a tray or drum dryer may find a greater field in handling finely divided materials, the rotary dryer may be successfully used by correct arrangement under similar conditions. As previously stated, I suggest a liberal use of trade papers and catalogs listing firms handling drying equipment. Use these as you do your chemical dictionary and your handbook on structural shapes, and you will doubtless find a way out of your difficulties. In submitting your problem, always give all available data and particularly the following:

Trade name of material.

Chemical constituents.

Wet or dry weight in pounds or tons per hour.

Moisture in material as delivered to dryer.

Moisture that may remain if possible.

Temperatures (F. or C.) to which material may be heated without injury.

Whether or not combustion or furnace gases are injurious to the material.

Physical characteristics.

Submit, if possible, a small sample of about 2 lbs. in sealed container, of nature in which it would be delivered to dryer.

If steam is available for drying, and at what pressure.

Cotton Figures Heavily in Chemical Industries. Cotton as a fabric material is a commonplace of everyone's daily life, but most people seldom think of the important part cotton as a chemical plays in their ordinary activities. G. J. Esselen, Jr., of Boston, speaking before the American Chemical Society at its Tulsa Meeting, pointed out the magnitude of cotton's share in American chemical industries. Nearly 190,000 bales were used during 1925, he told his hearers, in the manufacture of such diversified products as rayon or synthetic silk, celluloid, photographic films, automobile finishes and similar lacquers, artificial leather, paper, and explosives such as smokeless powder and dynamite.—*Science Service*

Diabetes Patients De-Vitaminized. Very unusual symptoms have been developed in diabetes cases when the necessarily restricted diet has failed to include vitamins A and B. Grave danger has resulted from the choice of diets for such patients not under the careful supervision of a physician.

Dr. Michael Wohl, of Omaha, brought about much discussion in the Section of the American Medical Association on Pathology and Physiology which met recently at Dallas, Texas, by bringing to light these new facts. Many cases were reported in which the importance of vitamins had been overlooked by patients on special diets.—*Science Service*

A SURVEY OF CHEMISTRY IN THE COLLEGES OF TEXAS

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The following data were obtained in a survey of the chemistry departments in the colleges and universities of Texas. The work was carried out by the class in "The Teaching of Chemistry," Prof. J. C. Godbey, Instructor, at Southwestern University. The data were gathered during the spring term of 1925, and refer, in nearly all cases, to the fall term of that year. The facts were ascertained from questionnaires and from personal conferences. Questionnaires were sent to all of the senior colleges and universities of Texas. Members of the class, or instructors, personally visited thirteen of the colleges concerned. The report includes seven state institutions and thirteen other colleges. The calculations have been made separately on these two divisions.

The chief purpose of this survey was to supplement the survey made by the same class the preceding year, which dealt with the science situation in the high schools of Texas, report of which was published last year. The object was to determine the effect of a student having had high-school chemistry on his probability of making a distinction or of failing in the college course. This, it was felt, would give a reasonable idea of the benefit of high-school chemistry as a basis for further work in chemistry.

A minor object was to determine the place of chemistry in the colleges, as regards the percentage of students studying chemistry, and the percentage of these who are in the advanced classes.

Table I gives the data on failures in the first year of college chemistry for the fall term.

Table II gives the data on distinctions.

Table III gives the data on the number of students enrolled in the various colleges, and the percentages of the students who are taking chemistry, either in the first-year course, or advanced work. It also shows the percentage of the first-year class that had had high-school chemistry.

A general idea of the attitude of college chemistry teachers toward high-school chemistry may be drawn from the questionnaires. The reports do not show that a single one of these Texas colleges makes a regular distinction in the classification of students who have had chemistry, and those who have not had it. A few teachers report that the plan has been tried and found unsatisfactory.

The following statements are quoted from teachers in representative institutions, as given in the questionnaires:

"Students having had high-school chemistry usually fail to study the first two months, thereby making low term grades. Students having had high-school chemistry should be in special sections. Most students are deficient in mathematics."

TABLE I

	No.	Students in 1st yr. chem.	With H. S. chem.	Without H. S. chem.	Failures of H. S. chem. students No.	%	Failures of students without H. S. chem. No.	%
State Institutions	1A	751	227	524	67	29.52	104	19.85
	2	862	314	548	41	13.06	287	52.73
	3	280	35	245	4	11.43	39	15.92
	4	78	22	56	0	0.0	7	12.50
	5	61	14	47	2	14.29	16	34.04
	6	60	10	50	0	0.0	0	0.0
	7	24	5	19	0	0.0	1	5.26
	Total	2123	627	1498	114	18.18%	454	30.30%
Other Institutions	1B	54	16	38	3	18.75	13	34.31
	2	238	123	115	13	10.57	22	19.13
	3	139	58	81	3	5.17	22	27.16
	4	100	64	36	5	7.81	8	22.22
	5	67	18	49	2	11.11	11	22.45
	6	70	17	53	4	23.53	15	28.37
	7	76	11	65	2	18.18	29	44.62
	8	44	8	36	0	0.0	8	22.22
	9	100	20	80	0	0.0	8	10.00
	10	26	4	22	0	0.0	2	9.09
	11	70	2	68	0	0.0	3	4.42
	12	15	4	11	0	0.0	6	27.27
	13	7	6	1	2	33.3	0	0.0
	Total	1006	351	655	34	9.68%	147	22.44%

TABLE II

	No.	Students with H. S. chem.	H. S. chem. students who made distinction No.	%	Students without H. S. chem.	Students without chem. who made distinction No.	%
State Institutions	1A	...	..	...	...	..	..
	2	314	25	7.96%	548	6	1.10%
	3	35	8	22.86	245	14	5.67
	4	22	7	31.82	56	3	5.36
	5	14	0	0.0	47	3	6.38
	6	10	5	50.00	50	15	30.00
	7	5	0	0.0	19	0	0.0
	Total	400	45	11.25%	965	41	4.25%
Other Institutions	1B	16	5	31.25	38	3	7.90
	2	123	13	10.57	115	6	5.23
	3	58	4	6.90	81	0	0.0
	4	64	10	15.63	36	3	8.33
	5	18	4	22.22	49	4	8.16
	6	17	1	5.88	53	1	1.89
	7	11	7	63.63	65	4	6.13
	8	8	1	12.50	36	2	4.41
	9	20	2	10.00	80	4	5.00
	10	4	1	25.00	22	5	22.73
	11	2	0	0.0	68	0	0.0
	12	4	0	0.0	11	0	0.0
	13	6	1	16.67	1	1	100.00
	Total	351	49	13.96%	655	33	5.03%

TABLE III

	No.	College enrolment	Chem. enrolment	% of college students in chem.	Number in 1st year chem.	% col. st's in 1st yr. chem.	H. S. chem. st's in 1st yr. chem.	% H. S. chem. st's in 1st yr. chem.
State Institutions	1A	4800	1210	25.20	721	15.64	227	30.23
	2	2398	1345	56.08	862	35.83	314	36.42
	3	1600	381	23.81	280	17.50	35	12.50
	4	977	110	11.25	78	7.98	22	28.20
	5	947	77	8.13	61	6.43	14	22.95
	6	700	80	11.42	60	8.57	10	16.66
	7	849	35	4.24	24	2.82	5	20.83
	Total	12,271	3238	26.39%	2116	17.24%	627	29.96%
Other Institutions	1	521	79	15.16	54	10.30	16	29.62
	2	1177	407	34.57	238	20.22	123	51.68
	3	1561	156	10.00	139	8.90	58	41.71
	4	1459	132	9.04	100	6.85	64	64.00
	5	315	84	26.66	67	21.23	18	26.86
	6	327	82	25.08	70	21.40	17	24.28
	7	950	101	10.63	76	8.00	11	14.47
	8	385	48	12.72	44	11.42	8	18.18
	9	788	121	15.35	100	12.67	20	20.00
	10	188	30	15.95	26	13.82	4	15.38
	11	867	79	9.11	70	8.07	2	2.85
	12	..	24	...	15	...	4	26.67
	13	220	13	5.90	7	3.18	6	85.71
	Total	18,758	1332	15.21%	991	11.32%	347	35.01%

"I do not find that high-school chemistry is much of an aid to college work. I would just as soon have students without it."

"I had two sections and placed, as far as possible, those who had had high-school chemistry or physics, and the premedical students in one section. My efforts to give a fuller course in that section met with failure—the other section could do better work."

Only two of the state institutions, and only four of the other colleges offer a course in "The Teaching of Chemistry." Very few, therefore, of the high-school teachers of chemistry have had definite educational training for their subject. A student certainly needs different training to be able to teach a science course with a laboratory, from that which he would need to teach non-science courses that do not have laboratory work.

Conclusions

Several important facts are evident from the survey reports. The first of these is the great need of some adjustment between high-school science and college science, so that a student may build upon the science which he has had in high school after he reaches college. Is the fact that students who have had high-school chemistry fail to show sufficient development over those who have not had it, due to the fact that it is poorly taught, or

is taught in too elementary a way in high school, or is it due to the fact that they are more or less bored by the repetitions of the first-year chemistry in colleges, and hence are not inspired to do their best work? Undoubtedly it is true that in most cases the high-school course in chemistry does not measure up to a first-year college course, and could not be substituted for it as a basis for advanced work. However, could not a course be offered that would cover the elementary work in a shorter time for those qualified to take it? A student with high-school chemistry should certainly be able to do one term of advanced work more during the first year than the student without any knowledge of chemistry. It seems that such a course would give more development to the student than one which is partly a repetition of high-school work. The question would arise, what should be the qualifications for entrance into an advanced first-year course? Should it be by examination, or by high-school record?

From Table I, we learn that the percentage of failures is almost twice as high for those who have not had high-school chemistry as it is for those who have had it. Table II shows that a student who has had high-school chemistry has five chances to make a distinction, as compared with two chances for the student who has not had previous training in chemistry. We must remember that these figures represent the status at the end of the fall term only. Judging from college teachers' observations, the difference in attainments of the two groups at the close of the first year would be decidedly less than for the first term. Data on this subject are needed.

It will be noted from the reports that the percentage averages are practically the same for the state institutions and for the other colleges. The only place where a large difference occurs is in the percentage of students taking chemistry. The larger percentage in the state institutions in this case is largely due to the Agricultural and Mechanical College of Texas, where 56.08% of the students are enrolled in the chemistry department.

It is interesting to note that the percentage of college students taking chemistry is practically the same as the percentage of high-school students taking any science whatever according to last year's report. This shows more science requirements, and more interest in science in the colleges than in the high schools. The state colleges show that 26.39% of their students are taking chemistry, 65.35% of whom are in the first-year class, and 34.65% in advanced work. The other colleges show 15.21% of the students enrolled in chemistry, with 74.40% in the first-year course, and 25.60% in the advanced classes. Colleges in large cities, generally speaking, and the Teachers' Colleges have lower chemistry enrolments than the other colleges, according to the report. It is regrettable that the colleges which are furnishing teachers should have such low records in the sciences.

Approximately one-third of the students in first-year college chemistry have credit for high-school chemistry.

Recommendations

1. The appointment of a committee to urge the coöperation of all of the college science teachers in keeping accurate records of the attainments of the students in the first year of college science for the present year, regarding their high-school preparation in science. This committee should also report the findings to the Science Section next year.

2. The appointment of a committee to investigate means of adjusting high-school and college science for mutual benefit. The committee to report next year.

3. The appointment of a committee to investigate certificate laws for high-school teachers, and to formulate a report, with recommendations to proper authorities. Why not issue a certificate permitting the teacher to teach only those subjects in which he is qualified? Some states are taking decided steps in that direction.

4. The coöperation of the science departments with the education department, to the end that a prospective science teacher shall have taken a course in methods pertaining to the subject that he is going to teach.

5. The insistence on the part of those interested in science that an increasing amount of science be taught, both in high schools and in colleges, and that a reasonable amount of it be required for graduation from any school. With the increasing number and complexity of modern apparatus, household appliances, and industrial processes of general interest, it is increasingly necessary that the student know the sciences, in order that he may understand and appreciate the world about him.

6. A more vital organization and coöperation of the science teachers of the state—both high school and college—so that progressive movements may be carried to a successful completion. Texas is one of the very few states that does not have a state organization of chemistry teachers.

7. The aiding of movements to popularize science, such as the American Chemical Society Essay Contest.

8. The regular study, on the part of science teachers, of good science periodicals, such as the JOURNAL OF CHEMICAL EDUCATION.

Editorial Note: It would be interesting to know what proportion of college teachers of chemistry share the view quoted from the teachers in Texas colleges in the foregoing article, to the effect that it makes little difference whether the college student has studied chemistry in high school or not. At Columbia University that view was held thirty years ago but has been considered antiquated for the past twenty years. For at least the past fifteen years the separate treatment of those who have studied chemistry in high school has been a policy so definitely settled and so uniformly followed as to be regarded at Columbia as a matter of course.—H. C. S.

All wish to know, but few the price will pay.—JUVENAL

WHY ARE STUDENTS NOT MORE INTERESTED IN CHEMISTRY?

DE WITT T. KEACH, YALE UNIVERSITY, NEW HAVEN, CONNECTICUT

A great deal is being said and written at the present time about making the subject of chemistry more interesting to the students in our preparatory schools and colleges. All of this apparently springs from an almost universal belief that there is something very wrong with the methods of teaching now in use. It cannot be denied that many students go through a course in chemistry without developing the slightest interest in the subject, and this in spite of the fact that the procedure in most courses has been developed with great care and that it is usually in the hands of good teachers. It would seem that there are some things which good courses and good teachers are incapable of accomplishing. A consideration of some of the schemes which have been, and are being, suggested is enlightening.

A plan often proposed to make the subject more interesting is to stress the applications of chemistry. To some extent probably all courses given in our schools today do go into the modern uses of the substances which the student is taking up. When the purely chemical matters about hydrogen, for example, have been disposed of, it seems very desirable to mention the uses of the element in inflating balloons, in connection with the oxy-hydrogen blowpipe and in the hardening of fats. But as a means of increasing interest in chemistry, it will be found that while some students become enthusiastic, a very considerable number are positively bored by the additional material. This has been the experience of the writer during ten years of teaching chemistry to college freshmen.

In connection with laboratory work it is suggested quite often that the experiments be so designed that the student will prepare substances which have practical application, that is, such things as ink, a dyestuff, etc. The claim is made that such a procedure secures the immediate interest of the student. Aside from the difficulty of developing a logical course using such methods, are we justified in the expectations? Those who are already strongly inclined toward chemistry will be delighted; the remainder for the most part will do the work with the same indifference that they would show toward any laboratory exercise.

Some teachers are much interested in the pleasing and, at first sight, promising idea of developing interest by utilizing the facts of the history of chemistry more thoroughly than is usually the practice. These people would give information regarding the great discoveries, show pictures of the great discoverers, etc. To some students this material provides fascination not to be resisted; the balance, if they have the opportunity, proceed to decorate the faces of the great chemists with whiskers, mustachios, or a pipe. And these latter are no more interested in chemistry than before.

Still another plan, very modern, is to use moving pictures and moving

diagrams in connection with the class work in chemistry. It is certainly to be hoped that this will be done increasingly; it will prove to be a boon in making some intricate subjects much more clear. But will it secure the interest of any larger proportion of the students than any of the other suggestions mentioned? Think of the opportunities of going to sleep while the pictures are being shown. Will the boy who is longing for the next period with the history teacher be greatly interested in chemistry by such a process?

Now it is not the purpose of this article to cast ridicule on these suggestions. Anything which secures the interest of *one* student is desirable and justified. But why is it that we are unable to secure the interest of all the class, not to the extent that they will all wish to become chemists, but that they will not be forever strangers to this most basic of the sciences? Before an attempt to answer this question is made, there is one other plan to be noticed.

A suggestion which is unfortunately being offered with more and more frequency is that we have a course which shall be a general introduction to science. In such a course it is intended merely to give general information without endeavoring to be specific in any sense. Such a course would not be one in which the student could be taught such items as equations, problems, etc., thoroughly; it would just scratch the surface or, in short, become a course of popular lectures in chemistry and physics. With the passing of all thoroughness would come the loss of all disciplinary value as applied to chemistry. The course would be popular because it is a rather rare student who is not attracted by a course in which he can attain a high grade without doing any work. But would such a course accomplish *any* valuable purpose? Would the interest in chemistry secured in this manner be of any use to the student?

Where then is the real difficulty in trying to interest more students in chemistry? The writer believes that the trouble is deep-rooted; that it goes back to the methods used in our primary and secondary schools. The great outstanding change in our schools in the past twenty years has been a change in the method of approach to knowledge. It used to be expected that the student would accomplish a good deal for himself; now everything possible is done to get him through a given course with the least effort on his own part. It is impossible to refrain from indignation when this is thoroughly considered.

An excellent teacher, head of the department of mathematics in the high school of one of our large cities, recently gave the writer the following information: An advanced lesson used to be announced to the students by saying, for example, that the next lesson would be pages 76 to 80, problems 1 to 10, inclusive, and it was then left to the student to dig his way through that lesson for himself. Today no teacher in his depart-

ment would be permitted to give out a lesson that way; instead the teacher must go over the advance lesson explaining every difficult point and doing several problems of the type to be studied.

This is but one example of many that could be given of the change in the method of approach.

Another fault of our present-day schools is that the memory is trained to the exclusion of all else. It is perfectly apparent that the effect of this is not good. If a student is given in his first year in college a lesson in chemistry which offers considerable difficulty, he will generally read it through several times and report at the next recitation expecting the instructor to explain all the difficult points. After the instructor has patiently explained everything several times, he is treated at the next recitation to a more or less accurate repetition of something he gave in his explanations, but is conscious all the time that the student does not know what he is talking about. There is absolutely no attempt made to develop the reasoning powers, and as a result the student avoids anything which even suggests thought, as he would avoid Bubonic plague.

What instructor does not have such experiences as this? He has carefully taught the principle that a basic oxide if caused to react with an acid will produce a salt and water, and he constantly gets equations like the following from his students:

$$2NaCl + H_2SO_4 + MnO_2 \longrightarrow Na_2SO_4 + Cl_2 + H_2O + MnO$$

The writer recently told one of his classes that they had acquired nothing in their preparatory school training in chemistry but the ability to memorize, and at the end of the hour about 50 per cent of the class (including some of the very best students) informed him that that was the only thing anyone had made an effort to teach them.

Here is an example of the teaching of arithmetic in the fifth grade of one of our cities. The problem is to divide 7.6532 by .076. According to the method in vogue it is done as follows:

$$.076\wedge\overline{)7.653\wedge2}\quad 100.7$$

In other words the scholars are taught to put the figures in a certain position as regards each other so that it will not be necessary to reason out as to where the decimal point should be placed.

The greatest lack in our schools, however, is that there is no teaching of the joy of accomplishment. The writer can remember how he was taught to take delight in seeing a problem through to the end, and ever since, when he has succeeded in handling something difficult, it has given him some of the greatest pleasure of his life. What joy has life to offer which is finer, or purer, than the joy of having done something worthwhile? And

it can be taught. It has been taught many times in the past. It can be taught to the growing child, slowly to be sure, but certainly, until everything taken up is taken up with the determination to make it yield that joy.

No scheme which we can put into effect in our teaching in chemistry, or any other subject for that matter, will secure general interest on the part of the students except in so far as we are successful in teaching the joy of accomplishment. This is very difficult if it is postponed until the student enters college. Our young people should be taught to reason, they should be taught to work and, above all, they should be taught the joy of doing worthwhile things with all their strength.

AVAILABLE MOTION PICTURE FILMS

The "Story of Dynamite" is the title of the latest addition to the list of educational motion picture films distributed by the Bureau of Mines for the purpose of visualizing various phases of the mining and allied industries. The film, which was produced in coöperation with one of the larger explosives manufacturing companies, depicts vividly modern methods of the manufacture of high explosives and illustrates the importance of dynamite in the mining, industrial, and agricultural life of the country. The mining and transportation of Chilean nitrate, the manufacture of wood pulp used as an absorbent, the various chemical processes involved in the preparation of ammonium nitrate and the conversion of sodium nitrate into nitric acid, the manufacture of nitroglycerine, chemical testing of the various ingredients, methods of transportation, and various uses of high explosives are included in the film. Copies of the film may be obtained from the Bureau of Mines, 4800 Forbes St., Pittsburgh, Pa.

A new educational motion picture film called "Through Oil Lands of Europe and Africa" has just been completed by one of the larger petroleum-producing companies for inclusion in the library of industrial films distributed by the Bureau of Mines. This film is divided into three parts of three reels each. The first part features the oil industries of Germany, France, Spain, Morocco, and Algeria; the second deals with the oil fields of Italy, Hungary, the Danube, and Roumania, while the third part features the Polish and Egyptian fields. In addition to showing the operations of the petroleum industry in the countries named, many interesting scenes portraying the life and customs of the inhabitants of the regions are shown. Any of the three parts of the film may be obtained from the Bureau of Mines, Pittsburgh, Pa.

The following films dealing with rubber are now available:

"How to Make a Rubber Tire," 1 reel, Ford Motion Picture Laboratories, Detroit, Mich.

"Rubbering in Selangor," 1 reel, National Non-Theatrical Motion Pictures, New York, N. Y. (Rubber Industry in the Malay States.)

"Rubber of Yesterday," 1 reel, Goodyear Tire & Rubber Co., Akron, Ohio.

"Fiji Does Its Bit," 1 reel, Pilgrim Photoplay and Book Exchange, Chicago, Ill.

"The Conductor," 1 reel, General Electric Co., Schenectady, N. Y. (Transformation of raw materials into finished lamp cord.)

An interesting 1-reel picture "Science of a Soap-Bubble" may be obtained through Pictorial Clubs, Inc., New York, N. Y.—*News Edition, Industrial and Engineering Chemistry*

THE TEACHING OF THE HISTORY OF CHEMISTRY*

WILLIAM ALBERT NOYES, UNIVERSITY OF ILLINOIS, URBANA, ILLINOIS

Teaching in our American colleges and universities is overburdened with the necessity of saying to a small per cent of our students that they have done so poorly in the course that they must repeat the work or give it up altogether, and of saying to another small per cent that they have done their work so well that they deserve special honors, or may be encouraged to follow the subject which they are studying as a profession for life. I see no very good way of avoiding the necessity of doing these two things, but while our work is overburdened by that necessity, it should not be dominated by it. Last spring in *Chemistry and Industry* there was a quotation from Le Chatelier which deserves repeating and emphasizing—"Young people are not receptacles to be filled; they are fires to be kindled." In the teaching of history or any other subject, it is important that we should remember this saying and unless, in some measure, we can kindle the enthusiasm of our students for subjects which we teach, we have failed.

Yesterday one of our speakers told the story of a young man who said to him that he "hated history." He succeeded in getting this young man to read John Fiske's "Virginia and Her Neighbors," and reports that when the young man had done this without the fear of an examination in his heart, he became greatly interested. I am sure that we will all agree that he learned a great deal more valuable history from reading John Fiske than he had learned from the dry bones of dates, wars, and political facts which had been taught him before in the class-room.

In studying history, and indeed, in studying almost any subject, it is quite essential that we should distinguish between an outline of important principles which should be impressed on the memory, and a large amount of other material which the student should not be expected to remember, but which should be allowed to pass through the student's mind with the expectation that from a large amount of material, a good, selective memory should retain some of the things of most importance. In this regard, the study of a scientific subject is somewhat like the study of the languages. I often say to students who are required to secure a reading knowledge of German and French as a basis for their chemical work, that they have looked up in the dictionary only a few of the English words which they use constantly and correctly, and I tell them that German and French words can be acquired in very much the same way; that until a student reaches the point in these languages where he can acquire the meaning of many words from the context, exactly as we learn the meaning of words in our mother tongue, he has no satisfactory command of the language. It is perhaps necessary in beginning the study of a language to learn a

* Delivered before the joint meeting of the Division of Chemical Education and the Section of the History of Chemistry of the A. C. S. at Los Angeles, August 6, 1925.

certain amount of the inflections and grammatical order of words characteristic of the language, but after that has been done and a comparatively small vocabulary acquired, the remainder of the knowledge of the language should be mostly obtained by the extensive reading of books and periodicals.

Somewhat the same principles apply in the study of the history of chemistry. The student should acquire a clear understanding of the broad outlines of historical development for the subject, and especially he should learn how men have built on previous knowledge, and have slowly found their way to a better understanding of the principles of chemistry. Having secured this general outline of the development of the subject, it is desirable that each student should read and become interested in the history of individuals who have contributed to the growth of chemistry. In carrying out these principles I have been accustomed to lecture one day each week, giving the story of the development of chemistry in as interesting a manner as possible. It is, of course, essential that students entering such classes should know the fundamental outlines of the science. In order to develop the second principle, I assign to individual students in the class, names of important chemists and ask them to report about these chemists those items which are of most interest, and require these students to make their report from the basis of brief notes and not by reading a prepared manuscript. This is done for two reasons. It is extremely desirable that men who are to follow the profession of chemistry should acquire the ability to give clear, interesting reports before an audience, and in the second place, those items which a student will remember and can give in this manner, are far more likely to be the sort of items that would be interesting to the class, and from which the class will receive benefit. Members of the class are, of course, encouraged to read from various books in connection with the study.

Sugar May Help Resist Infection of Joints. The sugar we eat may have a definite bearing on the ability of our joints to resist infection.

Dr. Ralph Pemberton, of Philadelphia, reported recently to the Section of the American Medical Association on Diseases of the Bones and Joints, that the amount of sugar digested in the body has a well-defined relationship to inflammation of the joints. In more than sixty persons with disturbances of the joints he found a low tolerance for sugar. Dr. Pemberton believes that control of sugar digestion is a factor in the healing of such diseases.

The condition is not the same as that which occurs in diabetes but seems to depend on some changes in the circulation of the blood. Low sugar tolerance was produced experimentally in individuals by changing the circulation through the administration of drugs. By these studies it was determined that sugar taken in through the mouth passes by way of the blood to the fluid of the joints and there is evidence indicating that it aids their resistance to infection.—*Science Service*

A METHOD FOR THE GRADING OF QUANTITATIVE CHEMISTRY LABORATORY DETERMINATIONS

WALTER S. FROST, UNIVERSITY OF NEW HAMPSHIRE, DURHAM, NEW HAMPSHIRE

One of the most perplexing difficulties of the professor of quantitative analysis is encountered in grading the results of his students' laboratory determinations on one fair and uniform basis, a difficulty which is not met to the same degree in marking examinations, quizzes, and reports. In the formulation of a scheme for grading students' analytical work consideration has to be given to:

(1) The weight, if any, which should be given to the agreement of duplicate determinations. This agreement will ordinarily be poorer in the case of a difficult analysis than in that of an easy analysis, but in any analysis the closer the agreement of duplicates the greater, on the average, is the skill of the student analyst provided the results are honestly obtained and reported.

(2) The credit which should be allowed for the degree of proximity of the average of the student's results to the correct value.

This latter is complicated by two considerations: (*a*) The magnitude of the percentage of the constituent to be determined. As much credit should be given when the average of the student's results is 0.3% away from a true value of 50% as should be given when the average is 0.15% away from a true value of 25%, other things being equal; (*b*) The greater the difficulty of the determination the more should be the allowable error between the student's average result and the correct result for a certain grade on the determination, provided that only one determination is to be graded. When several determinations of varying difficulty are to be graded, in perfect justice to the student, point (*b*) may be disregarded.

The greater the weight given to the laboratory grade in making up the final mark for the course, the greater the necessity of a suitable method for marking the laboratory determinations on an equitable and standard basis.

It is thought that such a basis is approached by the following scheme which has been used by the author for several years. It is predicated on the assumption that the students' results are honestly obtained and honestly reported. Education in dependability and integrity is believed to be one of the by-product values in the study of quantitative analysis.[1] Table I is used with the analytical results on samples that contain about 50% of the constituent that is determined.

The use of this table may not be instantly apparent. The vertical column at the left of the table is used for the difference between the average of the student's results and the correct value and the horizontal column

[1] W. S. Frost, *Science*, **58**, 256 (1923).

TABLE I. FOR 50% SAMPLES

		Difference between Duplicates					
		0–0.1%	0.1–0.2%	0.2–0.3%	0.3–0.4%	0.4–0.5%	0.5–0.6%
Difference between average and correct values	0.00–0.10%	100%	95%	90%	85%	80%	75%
	0.11–0.20%	90%	85%	80%	75%	70%	65%
	0.21–0.30%	80%	75%	70%	65%	60%	55%
	0.31–0.40%	70%	65%	60%	55%	50%	45%
	0.41–0.50%	60%	55%	50%	45%	40%	35%
	0.51–0.60%	50%	45%	40%	35%	30%	25%

at the top is used for the difference between his duplicate determinations on the same sample. (The numerical grades are in the main body of the table.) Suppose a student reported values of 52.42, 52.61 (Ave. 52.52) where the true value is 52.78. The difference between 52.52 and 52.78 is 0.26 which means that the grade will lie in the third horizontal column below the double line. The difference between the duplicate determinations is 0.19 which fixes the grade in the second vertical column to the right of the double line. Thus the grade for these particular results would be 75 per cent. In case a determination has to be repeated on account of inacceptable first results the grade is figured as above on the second results submitted if they are accepted, and a certain percentage such as 40 (varying with the difficulty of the determination) subtracted. If the second results are inacceptable and a third run has to be made a larger percentage is subtracted. No negative grades are given. Deducting these grades for inaccurate first runs puts a big premium on accurate first results on a new sample. A student is not compelled to submit his first results, however, if he is not satisfied with them. Other percentages than those suggested may be subtracted, varying with the difficulty of the determination. When a student's results are reported in triplicate, the maximum deviation is taken and this value used as the difference between duplicates. This ignores the fact that a third experiment has been performed but the student receives recognition for it in computing the deviation of the average from the true value. This gives a reward if two determinations are decidedly better than the third and a penalty if two determinations are decidedly poorer than the third.

The author likes to have samples for simple determinations, for example, gravimetric and volumetric Cl and CaO determinations, gravimetric SO_3 determinations, etc., which contain about 50% of the constituent and which vary progressively from each other in one set of samples by about 0.4–0.5%. This small variation puts at a disadvantage any student who attempts to compare his results with those of another student. Theoretically, using the proposed scheme the student who has the sample containing the lowest percentage of the constituent to be determined has an advantage over the student whose sample contains a higher percentage but since the samples

for any one determination differ but little and are given out at random and a number of determinations are run in a term, this slight disadvantage of the proposed scheme is practically eliminated.

In order to employ the same ideas used in the construction of the above table to other percentages than 50 all that is necessary is to change correspondingly the scales at the side and top of the table, as in Table II for 20% which is useful in grading soluble SiO_2 determinations in cement samples, etc.

TABLE II. FOR 20% SAMPLES

		Difference between Duplicates					
		0.0–0.4 %	0.4–0.08 %	0.08–0.12 %	0.12–0.16 %	0.16–0.20 %	0.20–0.24 %
Difference between average and correct value	0.0 –0.04%	100%	95%	90%	85%	80%	75%
	0.05–0.08%	90%	85%	80%	75%	70%	65%
	0.09–0.12%	80%	75%	70%	65%	60%	55%
	0.13–0.16%	70%	65%	60%	55%	50%	45%
	0.17–0.20%	60%	55%	50%	45%	40%	35%
	0.21–0.24%	50%	45%	40%	35%	30%	25%

The final grade of a student in quantitative analysis will include a grade in theory as well as laboratory work and the laboratory grade may well include grades on neatness and care, earnest effort, etc., as well as grades on the analytical results. In obtaining the latter, however, it is believed that the scheme suggested makes it possible to grade the students of a class on a reasonably fair and standard basis. It eliminates the personal equation.

UNITED STATES CIVIL SERVICE EXAMINATION FOR PHYSICAL CHEMIST

Receipt of applications for physical chemist will close May 25th. The examination is to fill a vacancy in the Bureau of Mines, for duty at Pittsburgh, Pa., and vacancies in positions requiring similar qualifications.

The entrance salary is $3800 a year. After the probational period of six months required by the civil service act and rules, advancement in pay may be made without change in assignment up to $5000 a year. Promotion to higher grades may be made in accordance with the civil service rules as vacancies occur.

The duties of the vacant position in the Bureau of Mines Experiment Station, Pittsburgh, Pa., are to be responsible for the work of a laboratory conducting research upon vapor pressures and solubilities and X-ray studies of minerals and alloys.

Competitors will be rated on their education, training, and experience; and writings to be filed with the application.

Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or the secretary of the board of U. S. Civil Service Examiners at the post office or customhouse in any city.

THE SERVICE SIDE OF CHEMISTRY

HERBERT R. SMITH, LAKE VIEW HIGH SCHOOL, CHICAGO, ILLINOIS

Effectiveness in education can be promoted most by some means that will make a student conscious of the service that any given knowledge can render in the things of daily life. It is possible, as has been whispered, that we must have new teachers trained to this point of view to accomplish it. But in science subjects so changeable in rapid development, in chemistry in particular, how can any real teacher remain static? It is over six years since a committee of the National Educational Association recommended in the reorganization of secondary schools that subjects be taught *from the standpoint of their service in life* rather than from the academic arrangement according to logical sequence for the subject's sake.

Not much heed has yet been paid to this advice by the teachers of any subject. In chemistry some promising titles have appeared on the covers of text-books but a perusal of the contents brings out the fact that the title is chiefly advertisement. The outlook is far from hopeless, however. The growing importance of chemistry will eventually compel the adoption of the service viewpoint. Further, if the American Chemical Society continues to function as progressively as it has during the last five years of its half century of existence, even static teachers cannot delay the progress of chemistry.

The service side of chemistry received special impetus during the war by the report on "The Future Independence and Progress of American Medicine in the Age of Chemistry" and the Prize Essay Contest has greatly helped the pupils' minds to reach forth for the values of chemistry. From the former the writer has taken the story of cocaine and developed it to local needs with results that have been surprising, judging from the pupils' frequent reference to and appreciation of it. It is herewith given more as a sample of a method of presentation than as a perfect example. The immediate objectives are to show the power of the chemist in finding facts by analysis, the importance of properties, and the vital service that chemistry can render. It should be told as a story with illustration of formulas, and not read from manuscript.

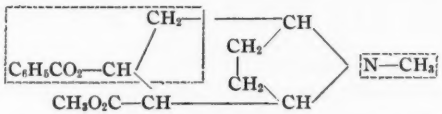
* * * * *

Physical pain serves to protect the body by making the individual respect it. To escape pain one must obey Nature's laws of health. But in the case of a necessary surgical operation, pain appears to be quite useless and generally harmful. Before anesthetics came into use about seventy-five years ago surgical operations were fearful experiences. In those days the patient was helped to bear the pain by being strapped to the operating table and the wound of the surgeon's knife was given final treatment with boiling oil.

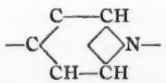
In 1772 Priestley discovered nitrous oxide and twenty-six years later Davy discovered its anesthetic properties. He wrote, "As nitrous oxide, in its extensive operation, appears capable of destroying physical pain, it may probably be used with advantage during surgical operations." It was tried but its effects were found to be too harmful, due to what we now know as poisonous impurities. It was fifty years later before ether and chloroform came into use so during all this time the human race endured the torture of surgical operations because chemical skill had not yet advanced enough to prepare pure nitrous oxide. This is one of the many ways in which the chemists' skill touches the lives of all people, so for their sake progress in chemistry should be promoted as much as possible.

But general anesthetics are not suitable for all cases. The condition of some patients makes their use extremely dangerous and in others the anesthetic has a greater ill effect than the operation itself. A substance, cocaine, obtained from cocoa leaves was found to cause insensibility to pain in that local part of the body into which it was injected. It gave great promise of being a suitable anesthetic for minor operations, but its use was also attended with ill effects even to fatalities in some cases. Chemical skill was able to purify it properly, so its poisonous properties were known to be a part of its nature. Since humanity was in dire need of such a substance several of the world's best chemists began to study cocaine.

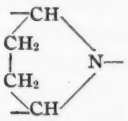
The molecule of a substance is too small to be seen by human eye even with the most powerful microscope so no one expects to be able to see the smaller atoms composing the molecule. But the chemist has an indirect way of seeing into a substance by means of the various chemical reactions to which he can subject it. The substances formed when it reacts with one reagent indicate some small part of the secret of the composition of the molecule and another reaction still more until finally the whole molecule is known. The patient efforts of these chemists were finally rewarded by a knowledge of the arrangement of the forty-three atoms in the molecule of cocaine. Having a chemical symbol of an element represent one atom of it the molecule looks like this:



It was further learned that the parts enclosed by dotted lines possessed the anesthetic properties and the part



had a close resemblance to poison hemlock, and the part



was very similar to the deadly poison nicotine.

The final solution of the problem was now before the chemists. The parts of the molecule having poisonous properties must be broken up and made over and the anesthetic properties retained. After much more painstaking effort a molecule was finally obtained which had this arrangement:

$$H_2N—C_6H_5—CO_2.CH_2—CH_2—N(C_2H_5)_2.HCl$$

If you have need of the ministrations of a dentist and there is a possibility of much pain he will inject into the tissues to be operated upon some of this refashioned cocaine, called procaine, which without the slightest danger to you will "steal away the sharpness" of pain. Do you appreciate the value of chemical knowledge?

UNITED STATES CIVIL SERVICE EXAMINATION FOR JUNIOR TECHNOLOGIST

Receipt of applications for junior technologists will close May 29th. The date for assembling of competitors will be stated on the admission cards sent applicants after the close of receipt of applications.

The examination is to fill vacancies in the Bureau of Standards, Department of Commerce, and in positions requiring similar qualifications throughout the United States.

The entrance salary for this position in the District of Columbia is $1860 a year. After the probational period required by the civil service act and rules, advancement in pay without material change in duties may be made to higher rates within the pay range for the grade up to a maximum of $2400 a year. Promotion to higher grades may be made in accordance with the civil service rules as vacancies occur. For appointment to the Field Service the salary will be approximately the same.

Examination will be given in the optional subjects of leather technology, oil technology, paper technology, rubber technology, and textile technology.

Competitors will be rated on general chemistry and elementary physics, mathematics up to and including calculus, and practical questions on each optional subject chosen.

The work of the Bureau of Standards includes many branches of physics, chemistry, and engineering, such as mechanics, heat, optics, electricity, sound, metrology, metallurgy, radio, electronics, engineering (gas, electrical, mechanical, etc.), also industrial technology, including research and standardization, and offers valuable experience in these professions, combining as it does theoretical, experimental, and practical work.

Full information and application blanks may be obtained from the United States Civil Service Commission, Washington, D. C., or the secretary of the board of U. S. Civil Service Examiners at the post office or customhouse in any city.

ARITHMETIC IN FIRST-YEAR CHEMISTRY*

H. P. WARD, THE CATHOLIC UNIVERSITY OF AMERICA, WASHINGTON, D. C.

Much thought and many words have been spent in the discussion of objectives in teaching high-school chemistry. The general tendency is to emphasize the facts of applied chemistry because these are of most practical value to the vast majority of pupils who study chemistry only one year and who never go to college. A writer in a recent issue of the JOURNAL OF CHEMICAL EDUCATION is so in favor of this practical objective that he would have nothing in the high-school course which did not bear some direct relation to everyday life. He would, among other things, eliminate all mathematics in first-year chemistry on the ground that it means nothing in the life of an intelligent citizen.

I have no doubt that this writer would not care to go on record as minimizing the importance of mathematics in the progress and appreciation of science. I am sure he would agree that the scientific mind is trained to the search for truth and this search is essentially mathematical and quantitative. It may be, however, that the ability level of high-school students can never be raised to the fullness of this appreciation. There is undoubtedly a big jump mentally in the capacity of pupils of high-school age and the mature students we get in college. Many of the latter fail to show an interest in mathematics anywhere near commensurate with its importance to science.

It is generally agreed that an appreciation of chemistry is a legitimate objective in teaching high-school chemistry. This cannot be done without mathematics. Nevertheless, if I were asked "Why teach chemical arithmetic in the high schools?" I should answer "Why, indeed?" The arithmetic required for first-year chemistry is just plain, simple, grammar-grade arithmetic. There seems to be no reason at all why the high-school teacher should have to spend his time showing pupils how to calculate. It is being done, however, not only in the high school but in college. It is astonishing at times to note the success and the ingenuity of certain students in complicating the simplest kind of arithmetical calculation. They are sure to get any problem involving numbers 100% wrong. I would say it was just a natural gift if it were not for the good money that somebody has spent for them to acquire it. So far as I can see, nothing can be done about such gifted minds. They simply cannot be made to calculate, no matter how much money is spent on their education. It is also my opinion that mathematically inclined minds—like poetic ones—are born, not made. Their owners calculate for the mere love of calculating.

Most of us belong to the middle class, both socially and mathematically. We like to do what is interesting to us. It is so with the average high-

* Read before the Washington Association of Chemistry Teachers on November 20, 1925.

school student who may like chemistry but not mathematics. His distaste for chemical arithmetic may be due to the fact that the solution of the problems involved in the ordinary course in general chemistry is made unnecessarily dull, if not unnecessarily difficult, by the use of too many mathematical schemes and formulas. For example, a writer in the JOURNAL OF CHEMICAL EDUCATION recently pointed out that there are at least six (6) different formulas proposed in high-school chemistry texts for the Laws of Boyle and of Charles. Perhaps the good pupil derives one of these formulas once and so justifies his use of it, but how many pupils simply memorize the formula of their text and solve gas-law problems in a mechanical fashion? Why not teach the solution of the gas-law problems by a method which insures at least some expenditure of mental energy in *thinking* as well as in memorizing? The gas laws should be associated in the pupil's mind with the Molecular Hypothesis. Gases should be thought of as freely moving molecules separated by space. Pressure brought to bear on gases will push the molecules closer together and thus decrease their volume, provided the temperature be constant. Again, speeding up the motion of the molecules by heat will cause the gas to expand provided the pressure be not changed. Thus any gas-law problem can be solved by multiplying the observed volume by two correction fractions as pointed out by a previous writer in THIS JOURNAL.[1] If this method of solving such problems is used constantly, the quantitative relations known as Boyle's Law and Charles' Law become firmly fixed in the pupil's mind which need not be burdened by trying to remember a formula that it may forget. Practically all the problems involved in first-year chemistry calculations can be attacked in this common-sense fashion.

It is not the purpose of this paper to point out the easiest methods of solving problems in general chemistry, but rather to emphasize the need of making pupils masters of chemical arithmetic. This requires constant drilling. A practice in use at this university is to devote part of our freshman laboratory time once a month to problem work. In addition, problems involving the usual types in general chemistry are printed on cards and are occasionally distributed to freshmen, in the laboratory, who may be waiting for a turn at the quantitative balances. The problems, as a rule, are all of a practical nature. If they are all of a kind, say on gas laws, we have the pupil work out the detailed answer of one or two problems and, for the others, indicate merely the method. This covers a lot of work in a short time and is primarily designed to emphasize the chemistry rather than the arithmetic of the problem.

It seems a good idea to reverse this practice once in a while and emphasize the arithmetic rather than the chemistry. The chemical significance of

[1] Stuart R. Brinkley, "Problem Work in General Chemistry," THIS JOURNAL, **2**, 136–41 (1925).

a problem is slow to be realized by beginners and, in our zeal to drive this significance home, we are tempted to pass over too lightly the arithmetical operations involved. Mournful numbers often come from careless calculating as well as from ignorance of the principles involved. The following type of problem can be solved with profit in first-year chemistry by even the most practical-minded, intelligent citizen-to-be, for he can apply it to everyday life.

Calculation of a Formula

Years ago, alchemists spent their lives searching for the philosopher's stone that could "preserve health, make the old young, turn the coward into a hero, strengthen the mind and sober the drunkard." ("History of Chemistry" by Ernst von Meyer.) Their search was vain.

Here is a good substitute for the philosopher's stone. There is enough for everyone, so calculate its formula and use your share. It has the following composition:

	Percentage composition	Atomic weights	Atomic ratios	Simplest whole numbers	Formula
Boron	2.66	10.9	0.244	1	
Radium	55.14	226.0	0.244	1	
Iodine	30.98	126.9	0.244	1	
Nitrogen	3.42	14.0	0.244	1	
Sulfur	7.80	32.0	0.244	1	

Blood Pressure Remedy Can Now Be Purified. The recently discovered liver extract used in reducing blood pressure can now be prepared in a comparatively pure state. In a paper given before the Section on Pharmacology and Therapeutics of the American Medical Association at Dallas, Texas, Drs. A. A. James, N. B. Laughton, and A. B. Macallum of London, Ontario, described their method of preparing this new remedy. They have succeeded in purifying this substance, which is made from fresh liver tissues, and in freeing it from dangerous chemicals. When injected into the body there occurs a rapid fall in blood pressure more pronounced and of longer duration than can be induced by any other known drug.

Dr. Ralph C. Major of Kansas City described another substance called "guanidine" which produces a rise in blood pressure when injected into the body. A decided elevation in blood pressure was produced in dogs by extracts made from several different organs of the body. That made from liver was found, however, more efficacious than anything else as a depressant. It is thought the method will eventually have great practical value in the treatment of this condition in human beings.

Dr. Joseph L. Miller of Chicago pointed out that there are many types of blood pressure that are due to changes in age and in these cases high blood pressure is possibly a necessary phenomenon. There is such great variation in blood pressure at different times even in the same person, he said, that the study of the effect of the various types of treatment is a difficult matter. Dr. Miller also indicated certain changes which are caused by emotional disturbance, by rest and sleep, and even by nightmares during sleep.—*Science Service*

GETTING OFF AT BALTIMORE

CHARLES H. STONE, ENGLISH HIGH SCHOOL, BOSTON, MASSACHUSETTS

When you are journeying from Philadelphia to Washington on important business, it is logical to remain on the train until you arrive at your destination; you do not get off at Baltimore. But in many of our schools we are often permitting such arrangements of laboratory procedure that our students "get off at Baltimore" instead of continuing to the end of their journey.

For example, we start Johnny on an interesting trip via the hydrogen route. He sets up his apparatus, puts zinc into the generator, pours in sulfuric acid, and collects the hydrogen produced. He observes the physical properties of the gas, tests it for its chemical properties, writes a record of his work including one or two equations, answers such questions as we may find time to ask him and the experiment is concluded. If he has avoided blowing himself up by a premature ignition of the hydrogen as it escapes from the generator, we send up a prayer of thanksgiving and start him on the next experiment which may be concerned with distillation or some other topic. Right there we are letting him "get off at Baltimore."

Is there any reason why he should "get off" there? Is it not important he should have something more than a theoretical knowledge of the fact that when zinc acts on sulfuric acid there is another product beside hydrogen? Is there any reason why we should let Johnny's opportunity for obtaining this product by filtration, evaporation, and crystallization pass? Won't Johnny have a much clearer idea of what really takes place when metal and acid interact if he prepares the secondary product? Will he ever forget the astonishing difference between the anhydrous and the crystalline forms of zinc sulfate if he has once prepared them himself? Why should we permit or require him to leave off his experimental work on a certain topic before it has been brought to a logical conclusion?

Over and over, teachers do this in the laboratory. How many of us have our students recover the potassium chloride and manganese dioxide from used "oxygen mixture?" How many of us have them recover the secondary product formed by the interaction of ferrous sulfide and sulfuric acid by filtering and crystallizing the ferrous sulfate? How many of us have them recover the calcium chloride formed when marble and hydrochloric acid are used to prepare carbon dioxide? And so on through the year.

If we can go a step farther and show a use for the recovered product so much the better. A little of Johnny's recovered manganese dioxide dropped into some fresh hydrogen peroxide will show by the liberation of oxygen that the catalytic power has not been lost through its first use with potassium chlorate. Ink can be made from Johnny's recovered copperas,

and he will be "tickled to death" to make some. His recovered calcium chloride will show that it is deliquescent if left for a day or two in a dry dish.

Other examples are not far to seek. The product left after preparing acetylene will yield some lime water if filtered; it will give a test for a base with phenolphthalein; and the dried residue will give a most satisfactory yield of ammonia if rubbed with a little of any ammonium salt. The copper nitrate liquid left from the preparation of nitric oxide will yield some fine copper oxide if evaporated to dryness with strong heat, and this oxide in turn will yield copper if reduced with hydrogen, thus getting back to the original metal with which the experiment was begun. The field is limitless for this sort of work and it is work that is worthwhile.

Are you letting your students "get off at Baltimore?"

Extract Replaces Sex Glands in Women. Scientists are now using what is thought to be the active principle of the ovary, or female sex gland, in treating women for several different diseases. Dr. J. P. Pratt of the Ford Hospital in Detroit and Dr. Edgar Allen of the University of Missouri in a paper delivered before the Obstetrics Section of the American Medical Association at Dallas, Texas, gave a report of their most recent observations on the ovarian hormone.

It is believed that this substance has an influence on the periodic functions of women. It has not yet been definitely established whether these functions are also controlled by other secretions in the body or by the same substance derived from other sources. This principle has been used in the study of the physiology of women whose ovaries have been removed and is said to produce a quite definite effect in such cases.—*Science Service*

Grape Seed Oil Greases French Motors. The manufacture of lubricating oil from grape seeds is a budding industry in the vine-growing sections of Central and Southern France. The new product has been found especially useful in the lubrication of delicate motors, particularly those of airplanes. Castor oil formerly used for this purpose has to be imported, while the vineyards south of the Loire furnish ample sources of supply for this new lubricant.

As the oil was first prepared it contained a rather high percentage of oleic acid which inhibited its use for many purposes but an improved chemical treatment has removed this difficulty. Its manufacture is now carried on in several cities in coöperation with distilleries. It has been estimated that between seven and eight gallons of oil can be made from the seeds of a ton of grapes.—*Science Service*

Alcohol Source Used in Movie Film Repair. Ethyl acetate, recently used by bootleggers as a source of alcohol, is used in repairing non-inflammable motion picture film, the kind used in the home movie machines which are now becoming so popular. These films consist of cellulose acetate, instead of the cellulose nitrate which is used in most of the theatrical production. Ethyl acetate, also known as acetic ether, dissolves cellulose acetate, and hence can be used as a cement for mending the films when they are broken. Amyl acetate, which is related chemically to ethyl acetate and is used for a cement for nitrate films, cannot be used on those of cellulose acetate.

When washing or baking soda is added to ethyl acetate a chemical change takes place and alcohol and sodium acetate are produced. The sodium acetate does not dissolve in the alcohol.—*Science Service*

CHEMISTRY AND ALCHEMY IN THE ARABIAN NIGHTS*

C. J. BROCKMAN, UNIVERSITY OF GEORGIA, ATHENS, GEORGIA

These "Nights," it seems, are the folklore of the natives of the desert and were collected for the first time about 1200–1300 A.D. in Arabic. There are several Arabic editions extant, each slightly different from the others, although all include more or less the same general tales with varying embellishments. However, the technic of these texts need not be discussed here. The importance of these "Nights" lies in the fact that they will contain science, if there was any science, which had developed up until they were set down in writing and even possibly some additions to the manuscript after their first writing. Therefore, it must be remembered that they do not deal with the alchemy of the later students but rather with the science which was based directly on the thought of the Greeks which contained very little alchemy.

The leading lady, *i. e.*, the story-teller of these tales was Queen Shahrazad, the daughter of a Wazir, who had "perused the works of the poets and knew them by heart: she had studied philosophy and the sciences, arts and accomplishments, and she was pleasant and polite, wise and witty, well read and well-bred."

It seems that the word chemistry is derived from the Greek $\chi\nu\mu\epsilon\iota\alpha$ or the Arabic "Kimiya" which properly means the substance which transmutes metals and is itself a wet drug used in the preparation of metals for coinage. In the Arabic the word means a coiner of monies. This substance, the philosopher's stone, was not a stone but in all probability a liquid. The stone idea must have developed through the desire for something rigid and permanent, *i. e.*, a stone which could be handed down from the master to his apprentice. To this word Kimiya the Arabs have prefixed their "Al" to form our present word alchemy.

Directions for transmutation are given as follows: "He cut a broken copper platter into bittocks and cast it into a crucible and blew upon the fire with the bellows until the copper became fluid, when the Persian put his hand into his turban and took therefrom a folded paper and opening it, sprinkled thereout into the pot about half a drachm of somewhat like yellow Kohl or eyepowder. Then he bade Hasan blow upon it with the bellows, and he did so till the contents of the crucible became a lump of gold." One-half a drachm of this powder was sufficient to transmute ten pounds of copper into pure virgin gold.

Among the synthetic foods which the Arabs were accustomed to using we find cheese, both cream and hard Syrian, and all the tropical fruits of Biblical fame. Fresh butter was set upon a fire, skimmed and kept in a leather bottle for a century—imagine that—it becomes a hard black mass that is

* Presented by title at the Spring Meeting of the American Chemical Society, Baltimore, Md., April 10, 1925.

considered a panacea for wounds and diseases, while at the same time has enormous powers as a food.

The Bedouins drank fermented liquors for the sheer pleasure of intoxication, the Koran notwithstanding. A prohibition drink was melted sugar in rosewater. When intoxication became undesirable the antidote was myrtle which served a dual purpose as a flavoring material for new brandy.

The perfumer and druggist and pharmacist did a great business. They had cures for everything although they failed to discover the elixir of life. The drugs were bhang, hashish, henbane, hemp, and myrtle. The native had an adroit and adept method of applying a soporate to his enemy without attracting any undesired attention. Treacle was a cure for the bites of venomous reptiles, etc.

Depilatories were considered harmful so that the hair of the axillary region was pulled out rather than shaved off; shaving in those torrid countries caused sores and other troubles.

Saffron was the greatest known aphrodisiac and one slave "announted herself with it till she fainted away from excess of volupty." Concoctions of boiled onions with other vegetables and condiments were almost universally used by all the sons of the desert as a cure for impotence and sterility, the most dreaded indications of the displeasure of Allah. The mystical and the fantastic with all sorts of incantations and "pow-wowings" were always included in the applications of these cures, the results being uniformly successful in all cases.

The Bedouin has a peculiar idea of beauty and makes unique demands as to what the women of the tribe shall do to enhance their beauty along the lines that appeal to him. Henna is a color that has a most wonderful attraction for him. To make themselves more appealing the houris and dancing girls colored their finger and toe nails with this dye which must have been a rather weird combination in the light of present day usage. The henna of the Arab was the same as the henna of the present dye industry.

When Allah showed Himself to Moses on Sinai through an opening the size of a needle, the Prophet fainted and the Mount took fire; thereupon Allah said, "Henceforth shalt thou and thy seed grind the earth of this mountain and apply it to your eyes." From this admonition arose the use of Kohl. The Arabic word does not mean a collyrium but means powdered antimony for the eyelids. The powder is kept in an étui called Makhalah and is applied when needed with a thick blunt needle to the inside of the eyelid, drawing it along the rim rather than at the roots of the eyelashes. The aristocracy used Kohl but the poorer classes used a preparation of soot or lamp-black, the color of which may easily be distinguished from that of Kohl. Galena or lead sulfide may also be used.

Originally the use of Kohl was a protective measure. The great brilliance of the sun in the desert regions of Arabia causes severe attacks of ophthalmia unless some means of protecting the eyes is available. From a necessity it soon spread to a custom especially among the women. "A young lady, fair of form, oval of face, perfect in grace, with eyelids which Kohl-lines enchase." The native women soon learned that the proper application of Kohl to the eyelids gave them a peculiarly languorous appearance that was invaluable to their happiness. The Arabs being dark complected and probably brown eyed, the blackened eyelashes accentuated the size of the eyes so that there was a similarity between the languorous look of the houri and dilation and brilliance of the eye in the case of modern intoxication. It is probably a long jump from the Arabic word Kohl to our present term alcohol. But even the Arabs had prefixed their "Al" making the term Alkohl from which it is not very difficult to trace our word alcohol, the appearance of the eye in each case being very similar. To trace a derivation through the older term "spirit of wine" would be more difficult. Where the modern physician uses an argyrol solution the Arabs "darkened the eyes of a new-born boy with Kohl to prevent inflammation."

The mention of glass vessels in the Bible is very unsatisfactory and the translation of some of the original Greek and Hebrew words to the modern idea of glass is sometimes questioned. Whether or not the people of Biblical times knew how to manufacture glass may be left for others to decide, but the Arabs were very adept at preparing glass vessels for their spirituous liquors. They preferred, however, to keep their drinks in earthen jars. The earthen material was porous and although the liquid did not seep through it rapidly enough to be lost in great quantities, it did seep through in large enough amounts to cool by evaporation the whole vessel, including the liquid inside, to a temperature that made the drink very palatable in so hot a climate.

There is much in the "Nights" that is fantastic and mystical but there is a great amount of information that must be more or less a true statement of what the natives were doing and thinking. In places these Arabian Nights might well be called the popular chemistry of the Arabs. Although they are voluminous to a disappointing degree and by no means a treatise on the chemistry of that age these "Nights" possess a fascination which makes them what is now called "interesting reading."

I do not know anything, except it be humility, so valuable in education as accuracy. Direct lies told to the world are as dust in the balance when weighed against the falsehoods of inaccuracy; and accuracy can be taught.—SIR ARTHUR HELPS

IS A MEETING OF COLLEGE CHEMISTRY STUDENTS WORTHWHILE?

ROBERT M. LINGLE, PUBLICITY CHAIRMAN, INDIANA SECTION AMERICAN CHEMICAL SOCIETY

Four years ago the members of the Indiana Section of the American Chemical Society conceived the idea that they should be of assistance to the chemistry student who is about to enter commercial life. Accordingly invitations were sent out to the colleges and universities within close range of Indianapolis asking junior and senior chemistry students and their teachers to come to Indianapolis for one day to take advantage of inspection trips through manufacturing plants and to listen to worthwhile speakers.

Committees were appointed to arrange for inspection trips through the manufacturing plants, to get speakers and to arrange exhibits. About one hundred visitors were entertained in 1922.

In 1924 the second meeting of this nature was held. This time we arranged to have the students here for two days instead of one because in the previous meeting it was found that one day did not allow the students time enough for the inspection trips. Cards were sent out about two weeks in advance for registration so that the plants could be advised of the number of visitors which would be present. There were two or three optional groups of trips each day. A special afternoon program on chemical education was arranged for the teachers. After the banquet which was held in the evening of the first day, there was the usual introduction of local officers and committees, and of the visiting faculty members, followed by an address by a nationally known chemist. The last afternoon was devoted to a discussion of the chemist and his job. About 130 visitors attended this meeting. These opening paragraphs have given a brief history of our two previous meetings. A rather comprehensive report of the meeting which has just ended, follows.

Arrangements for the 1926 meeting began in the autumn of 1925 with the appointment of a general committee of three, Wm. Higburg, F. G. Jones, and R. N. Harger, who were to select such sub-chairmen as seemed necessary, to arrange a date suitable to the visiting students, and to be responsible for the whole meeting, leaving the local officers free to carry on the regular business of the Section. As you may know, the Section has a noon luncheon every Tuesday as well as the regular monthly evening meetings.

The following sub-chairmen were next chosen: Arrangements, H. E. Cory; Attendance, F. F. Havey; Inspection trips, J. H. Waldo; Publicity, R. M. Lingle; Exhibits, C. K. Calvert; Registration, Neil Kershaw; Guest Reception, H. A. Shonle.

A full two days' program was arranged for April 2nd and 3rd, giving the most emphasis to inspection trips. The speakers were selected for their abil-

ity to help the student find himself after graduation. A special speaker was invited in for the afternoon faculty session of chemical education. As in the past the visitors were charged a registration fee of $1.00 merely covering the cost of the dinner, while the local members agreed to pay $1.25 for registration. Through the courtesy of Eli Lilly & Co., and the Van Camp Packing Co., complimentary luncheons were served to the guests

Officers of Indiana Section and Student Meeting Committee.

Back row, left to right: R. N. Harger; F. F. Havey; Robert M. Lingle; Cecil Calvert; J. H. Waldo; F. G. Jones. Front row, left to right: E. L. Keeler, Editor, *Accelerator;* H. E. Cory; Neil Kershaw, Sec. and Treas.; Horace A. Shonle, Chairman of Section; Wm. Higburg, Chairman of Student Meeting; Paul Smith, Vice-Chairman of Section.

and members. The Local Section paid all other expenses, somewhat less than $150.

Colored posters, prepared for the bulletin boards of the schools, letters were sent out at regular intervals to the students, several weeks before the meeting, advising them of the inspection trips, exhibits, and speakers. Cards for advance registration of trips were also sent out. This is necessary since the students arrive during the early morning, registering between 7:30 and 8:30 and leave for the inspections by 8:45. Copies of the *Accelerator*, the monthly publication of the Section, were sent each student

who had expressed a desire to attend. The issue a month prior to the meeting contained general information, while the "Student Meeting" issue which contained the complete program, was mailed one week before the meeting.

Two hundred and twenty-five students and teachers registered from seventeen different colleges and universities in addition to some seventy members of the Section. One hour was taken up in registration at the Chamber of Commerce, this place having been chosen as the headquarters of the meeting. From there the various groups in charge of a guide were loaded into busses and started on the inspection trips.

While waiting for registration, an opportunity was given to view the exhibits which had been prepared during the earlier part of the week by various firms of the city and state. These had been placed in a prominent position at the Chamber of Commerce and the citizens of Indianapolis became so interested in them that they were exhibited at the public library the next week.

At noon, Friday, the visitors were assembled at the plant of the Van Camp Packing Co. and given a complimentary luncheon. After luncheon a short talk was given by Dr. Neil Gordon, Editor of the JOURNAL OF CHEMICAL EDUCATION. Then followed an inspection of the Van Camp plant which consumed nearly the entire afternoon. At three-thirty the faculty members adjourned to the Chamber of Commerce to hold their meeting on Chemical Education, Dr. Neil Gordon presiding. Dr. Gordon presented to the meeting the question of the type of course best suited to the needs of the high school. Some forty professors and a few high-school men with several interested industrial chemists composed the audience. The meeting was unanimous that a not too comprehensive course, containing a modest number of fundamental laws and theories, together with basic principles and a fair number of useful facts would be best both for the student who was to follow up chemistry in college and the student who might not go to college. The college professors were emphatic in deprecating any attitude of "knowing it all" on the part of the college freshman who had had high-school chemistry. Where such an attitude results from high-school chemistry the professors were a unit in saying they would rather the student had not had high-school chemistry.

The lack of suitable preparation on the part of teachers of chemistry was blamed by many of the professors as the primary cause of many of the unsatisfactory results in the high-school product.

Friday evening a banquet was held at the Chamber of Commerce. Wm. Higburg, general chairman of the meeting presided. Governor Ed. Jackson was present and gave an address of welcome to the guests which was followed by remarks from a faculty member of each college represented. The principal address of the evening was given by Mr. William Hoskins

of Chicago who spoke on the subject "The Genesis of an Industry." This address was of special interest to students in that Mr. Hoskins pointed out the failures that occur in the research experiences of young chemists just starting out from college and showed them that it was only by constant application that they could expect to succeed.

Saturday morning the plants of the Indianapolis Paint and Color Co. and Eli Lilly & Co. were inspected, the latter company serving a complimentary luncheon. Immediately after the luncheon, Dr. Otto Eisenschiml of Chicago discussed the "Chemist and His Job." He gave the student an idea of how to look for a position, how to get started on his work in order to make the best impression, and how to win promotions. As a conclusion to the regular program Mr. Calvert conducted an inspection through the Indianapolis Sewage Disposal Plant, about fifty people taking advantage of this opportunity. The active and professional members of the Alpha Chi Sigma fraternity concluded the week-end program by having a banquet at the Columbia Club.

As far as can be learned this is the only meeting of its kind held in this country and the Indiana Section is desirous of seeing other Sections follow a similar plan. The student in the average college does not have the opportunity to inspect commercial laboratories and plants and as a rule does not know what to expect after graduation. The success of a meeting of this kind depends on the active coöperation of the committees appointed. The students must be impressed with the fact that it is worth their while to see exhibits covering all types of industry; to see plants in operation under chemical control; to be addressed by men who have had years of experience in chemistry as applied to industry; to come in contact with men in the profession who are ready and willing to meet and help them; and to meet and exchange ideas with fellow students from other schools. It is also necessary to get the faculties interested so that they will give encouragement to their students to attend. The speakers on the program should be balanced by giving the student both sides of chemistry as applied to pure research and to commercial work.

Each meeting that has been held has been better in attendance and interest than the preceding ones. Are they worthwhile? Ask any faculty member in Indiana or any member of the local section of the American Chemical Society and you will certainly receive an affirmative reply.

Scientific thought does not mean thought about scientific subjects with long names. There are no scientific subjects. The subject of science is the human universe; that is to say, everything that is, or has been, or may be related to man.—W. K. CLIFFORD

MEETING OF THE SENATE OF CHEMICAL EDUCATION AT TULSA, APRIL 5, 1926

The first meeting of the Senate of Chemical Education of the A. C. S. was called to order by its chairman, Neil E. Gordon, on April 5, 1926, at 10 o'clock in the Mayo Hotel, the headquarters of the Tulsa Meeting of the Society. The following members and proxies were present.

Bartow, Edward, Iowa
Bawden, A. T., Kansas
Billings, Erle M., New York
Botkin, C. W., New Mexico
Brown, F. E., Iowa
Clark, John D., New Mexico
Clinton, Guy, District of Columbia
Dahm, H. L., Missouri
Dains, F. B., Kansas
Esselen, G. J., Jr., Massachusetts
Faragher, W. F., Pennsylvania
Glasoe, P. M., Minnesota
Gordon, Neil E., Maryland
Gustafson, C. F., Missouri
Hendricks, B. C., Nebraska
Hopkins, B. S., Illinois
Hoover, C. R., Connecticut
Jensen, J. H., South Dakota
Leach, L. O., Arkansas
Maxson, R. N., Kentucky
Mooney, H. N., Illinois
Mudge, W. A., West Virginia
Reed, G. Nathan, Oklahoma
Robertson, Percival, Missouri
Swan, J. N., Mississippi
Voter, P. C., Vermont
Walker, H., South Dakota
Yates, J. A., Kansas

Since this was the initial assembly of the Senate the first part of the session was devoted to organization. B. S. Hopkins of the University of Illinois was elected secretary. It was moved and carried that members unable to attend a meeting of the Senate may appoint substitutes to act for them, but that such appointments must be made in writing and are to be presented to the chairman of the Senate on or before the date of the meeting.

A letter ballot taken some time previously had elicited a general expression of opinion as to what projects should be considered by the Senate and the relative order in which they should be taken up.

After some discussion it was agreed that the Committee on Chemical Education should, in coöperation with other special committees, make a study of and outline a course of action leading to a solution of problems connected with:

1. Educational standards for high-school teachers.
2. The content of the high-school chemistry course.
3. The equipment essential for the teaching of high-school chemistry.

The plans so formulated may be reported to the Senate at the fall meeting in Philadelphia for possible modification, approval, and further action. The question as to whether or not these movements should lead to the preparation of an accredited list of high schools was left open for the present.

Further problems which received no discussion because of lack of time but which may be reported at Philadelphia by special committees are as follows:

1. Plans for the vocational guidance of chemistry students.
2. Plans for a broader and more thorough training of college chemistry teachers.
3. Plans as to how recognition can be given to the teachers of chemistry which will be comparable to the recognition given for investigational work.
4. Plans for research in chemical literature.
5. Chemical engineering education.

The Senate also voiced an opinion that there is as much need for German teaching in high schools today as there was previous to the war.

The Senate is one of the most representative bodies ever organized for the study of scientific education. The scope of its activities will ultimately include the entire field of chemical education, high-school, college, and industrial. Throughout, it will aim to correlate and harmonize all phases of the educational program, with a view to the elimination of friction and duplication of effort. The inclusion on an equal basis of high-school, university, and industrial men in its membership offers splendid advantages for the success of such a course.

No project in chemical education can be so readily inaugurated, with so favorable chances for receiving the approval of the Society as through support of the members of the Senate. This will protect the Society and assure that no work of very limited or only local interest will be carried out at its expense and should guarantee that all final recommendations will be well-considered and balanced.

B. S. HOPKINS, *Secretary*

SOURCES OF FREE MATERIAL FOR USE IN THE TEACHING OF NATURAL SCIENCE

The University of Oklahoma has issued, under the above title, a thirty-five-page bulletin which should prove exceedingly valuable to science teachers.

This bulletin contains a comprehensive list of charts, exhibits, literature, slides, and films which may be obtained free of charge from industrial concerns and educational agencies. It describes briefly each piece of material and classifies it with respect to its suitability for physics, chemistry, the biological sciences, and general science. In compiling this bulletin, inquiries for free material were sent to over four hundred firms and societies, while more than twelve hundred pieces of material were received and examined.

The Department of Physics has available for free distribution some thirty other monographs and bulletins for science teachers. A list of these publications is sent free to teachers upon request.

MINUTES OF THE MEETING OF THE DIVISION OF CHEMICAL EDUCATION AT THE TULSA MEETING, APRIL 5–8, 1926

In the absence of the chairman, the meeting was called to order by Professor H. P. Cady, vice-chairman. The first section was devoted to a symposium on "Orientation and Segregation as Applied in Chemical Education." Methods of sectioning according to ability were reported as follows: University of Maine, C. A. Brautlecht; University of New Mexico, John D. Clark; University of Iowa, Edward Bartow; University of Pittsburgh, Carl J. Engelder; University of California, Merle Randall. In addition brief reports were made from Purdue, Nebraska, Mississippi, and Northwestern. Many schools use the Iowa placement tests for determining relative abilities; others use the army intelligence test, a psychology test, or a test in simple ratio and proportion with a little simple algebra. In some places the system of sectioning according to ability has been in use for twelve years or more and the universal opinion indicated that the plan has decided advantages. The chief value lies in getting students of like abilities in groups by themselves. The good students are stimulated to greater excellence especially if they are confronted with the danger of demotion for inferior work. Students in the intermediate sections who have an opportunity for advancement are generally eager to win promotion and those in the lower sections realize the need of greater effort if they are to succeed, while faults in previous preparation may be systematically corrected by extra work. Grades in the initial placement tests are generally an accurate index to the final grades in the course, although there are notable exceptions. The value of segregation lies not so much in permitting a predicted final grade as in classifying the students into groups which begin with an equal chance. It is significant that no institution reported dissatisfaction with the plan which is reported as furnishing inspiration to both strong and weak students with beneficial results to all.

Following the symposium a varied program of papers of interest to teachers of chemistry was given. Since these papers will be published in full in THIS JOURNAL, only the most general impressions can be given here.

"Putting the 'Is' in Chemistry" was the subject of an inspiring address by G. J. Esselen, Jr., of Boston. If chemistry is to mean anything to the student, it is necessary to create an interest in the subject and to maintain that interest throughout the entire course. This can best be done by showing the applications of chemistry to modern life. If we show the service of chemistry in producing and maintaining food supplies, in supplying clothing, building materials, and numerous conveniences, the luxuries of yesterday which have become the necessities of today, chemistry ceases to be an academic nightmare and becomes a living,

factor in modern life. It is not necessary to sacrifice the theories of chemistry in order to emphasize its applications, but it is possible to teach fundamentals thoroughly and to make them attractive by showing their applications.

The excellent work which is being accomplished by the Prize Essay Contest was outlined by H. E. Howe, Editor of our Industrial Journal. The work of Dr. Howe's committee is tremendous in its proportions, and the cost of the contest represents a material expenditure, but the interest aroused in chemistry is most gratifying. For next year the contest is to be continued in the high schools on the same plan as last year; in the colleges it is to be limited to students in the freshman class. It is to be extended also to include normal schools and teachers' colleges. There is need of greater interest in college circles and the creation of interest depends largely on the teachers. All chemists are urged to boost the Prize Essay Contest in their own localities, especially among students who are eligible to enter the competition.

"The Status of Chemistry Teaching in the Southwest" was outlined in a paper by Cliff R. Otto, who called attention to the fact that, while some states in the southwest were making splendid progress in teaching chemistry in secondary schools, other states were falling behind. Any national standards which are adopted must take into consideration the status of chemistry in these states, and the national organization should aid as much as possible in promoting the interests of chemistry in these localities.

A preliminary report on the general features of the task of planning a chemical laboratory was made by J. N. Swan, whose committee has been making a systematic study of the problem. The main features of an efficient and economical building were outlined. A later report dealing with special features of interior arrangements is promised.

Various devices for insuring individual work in the laboratory and for developing the habit of independent thought were discussed. Means of teaching the periodic system, qualitative analysis, quantitative analysis, the chemical equation, and other puzzling portions of the teacher's task were discussed and valuable suggestions made.

The closing session of the Division was a joint session held with the Section of Chemical History, F. B. Dains, presiding. An interesting paper, illustrated with slides, on "A Chemical Laboratory Two Hundred Years Ago" was read by F. B. Dains. "Faraday's Discovery of Benzene" was described in a paper by L. C. Newell.

An illustrated talk on "John Dalton and His Work" was given by H. F. Coward, of Sheffield, England, who has had unusual opportunities to investigate Dalton's life and work. The methods of using chemical symbols, the beginnings of molecular structure, and the close approach

to the idea of isomeric compounds and the use of chemical equations were points of unusual interest. Pictures of Dalton's original apparatus were shown.

The closing paper was a valuable demonstration of the use of motion pictures, especially with the compact kodoscope, in visual chemical instruction. The taking of such pictures requires little time and the cost is moderate. The possibilities for showing both correct and incorrect manipulation and for illustrating manufacturing processes are unlimited.

A brief business meeting was held in which reports from the following committees were presented: *Nomenclature*, A. P. Sy, *Chairman; Research on Problems of High-School Chemistry Instruction*, Earl R. Glenn, *Chairman.*

Because of lack of time these reports were referred to the Committee on Chemical Education for consideration and action.

Plans for the Philadelphia Meeting were discussed. It was voted to recommend that three groups of papers be called for, based upon the following central thoughts:

(1) History of Chemical Education during the past 50 years, with a prophecy concerning the future. This may be a joint offering with the Section of Chemical History.

(2) The Status of Chemical Engineering Education, in conjunction with the Division of Industrial and Engineering Chemistry and the Committee of Chemical Engineering Education.

(3) Types of Chemical Education employed in other lands, if visiting chemical educators can be secured to speak.

Two additional committees were added to our list:

Research on Problems of College Chemistry Instruction.

Aids to Visual Chemical Instruction.

B. S. HOPKINS, *Secretary*

Motor Fuel Made from Water and Coal. How synthetic fuels for internal combustion engines may be made from coal and water was described at the Tulsa Meeting of the American Chemical Society by C. R. Hoover of Connecticut Wesleyan University, and associate investigators. The material employed in the process is the familiar water gas, made by passing a current of steam over a bed of red hot coal. When this water-gas is conducted at high temperature and pressure over a catalyzer, such as finely divided nickel, copper, iron, or other metal, the carbon in part combines with the hydrogen, giving a gaseous mixture that contains from twenty-five to thirty per cent of compounds of higher heating value. By increasing the pressure of the process it is possible to obtain compounds containing oxygen as well as hydrogen and carbon, such as alcohols and aldehydes of various kinds, some of which may prove on further investigation to have commercial possibilities.—*Science Service*

Correspondence

DIFFERENTIATED CHEMISTRY FOR GIRLS

TO THE EDITOR:

I am not only much interested in but highly approve of Mr. Humphrey's letter on Making Chemistry a Required High-School Subject, published in the February JOURNAL OF CHEMICAL EDUCATION.

In this connection, may I put in a plea for more differentiated chemistry for girls? Girls, as a rule, care nothing about a discussion of the manufacture of sulfuric acid but are vitally interested in how to take out all kinds of stains on clothing and household fabrics. The oxy-hydrogen blow torch arouses their interest but little, while the hydrogenating of cottonseed oil to a white, solid fat so useful in the kitchen, gives them all the thrill of a romance. The testing of the caloric content of coal has little appeal for the girl, but a discussion of the burning of coal without smoke leaves them gasping with delighted hope of the future and at the same time fills them with indignation that they have fought the demon dirt for even their few years, because of the ignorance and carelessness of men.

The metallurgy of metals interests the average girl very little, but they are all glad to learn of the chemical action of the metals used in the home; why different metals are used in various places (such as in cooking utensils, the garbage can, water pipes, drain pipes, bath room fixtures, table ware, kitchen cutlery, etc.), and how and why each metal is best kept clean and bright.

Food chemistry, closely linked with physiological chemistry, in a class to themselves with no boys to disturb their frank discussion of domestic problems, is a fascinating subject to the average girl. A place to make a real chemical study of the different kinds of sugars, to observe the different steps in the breaking down of starch and to work out practical applications of the chemistry of the carbohydrates to the selection and preparation of food. A laboratory to study the chemistry of fats and their relations to the diet and to the cleaning problems. A workshop to actually study chemically (not make a few superficial tests on) representative protein foods, such as meat, milk, gelatine, cheese, eggs, ice cream, drawing practical applications for use in daily life. Then, a study of the chemistry of the secretions of the human digestive tract and their action on the various classes of foods, bringing home to them that what we feed people makes them.

These are but a few of the hundreds of units of chemistry (inorganic,

organic, food, and physiological) which can be made vital to the girls in our high schools today—in classes to themselves. It seems to me that every girl in our country should have some such specially worked out course in chemistry sometime between the ages of fourteen and nineteen.

It is deplorable how little women of my own generation, who are mothers and directors of homes, know of chemistry and all its valuable helps. If they studied chemistry in high school or college, they invariably tell me that they hated it and got nothing out of it but their credit. It seems to me that we must right this situation by properly preparing our next generation of women in high-school chemistry.

AGNES F. JAQUES

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"PANDEMIC CHEMISTRY"

TO THE EDITOR:

I have just read with interest the April number of the JOURNAL OF CHEMICAL EDUCATION, and particularly the editorial, "The Inarticulate Scientist," and Dr. Bancroft's article, "Pandemic Chemistry."

Perhaps you may not have noticed it, but there seems, at least to me, quite a close bond of union between these two articles. After reading both of these, the question occurred to me, "Why not assign the lectures which Dr. Bancroft enumerated to the students and have them report upon them to the class?"

During my regency at John Carrol University, Cleveland, Ohio, I assigned topics to my students and had them report upon them. My reasons were several. The students would thereby acquire a facility in expressing their thoughts in writing and an ease in speaking before a group of people. Again they would learn how to use magazines and various books of reference and lastly they would take an added interest in chemistry. I am glad to be able to report that, without an exception, the results which I anticipated were obtained.

I regret that I did not then have such a splendid list of subjects as I now have after having read Dr. Bancroft's article.

In looking over this list, I notice that there are some topics which the student could not handle. In such instances I would suggest that the teacher develop these subjects.

As to the time when these lectures could be worked in; it would depend upon local circumstances. In some places an extra hour could be added provided the Dean were willing; in other places the time could be taken

from a laboratory period or even, now and then, from a lecture period. I was obliged to take one of the lecture periods.

I limited the length of the report to 200 words and thus about five students were able to report in one period. Comments were made and questions asked after each report. The students were required to do this twice a year. Of course, not all of the students were able to report to the class, but they were required to hand in their papers and then to report for a criticism of the same. I think that, with a few modifications, this plan could be carried out with larger classes as well.

I would be glad to exchange opinions with you or any of the readers of the JOURNAL on this subject.

ADAM J. KELLER

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ST. LOUIS, MISSOURI

Few Drug Users Found in England. While addiction to morphine and heroin in Great Britain is growing rare, a complete cure, especially of the heroin addicts, is difficult to obtain. This is the finding of an investigating committee of physicians which has reported to Parliament.

Since harmful use of drugs has often resulted from their use in medical treatment, the committee warned practitioners to administer drugs with caution, especially in the case of very young patients. The most important predisposing cause of addiction was found to be inherent mental or nervous instability, although chronic pain, insomnia, overwork, and anxiety are also prevalent causes. According to one medical witness examined by the committee, there is, however, danger in some cases of administering the drug too late. The worn out patient has such intense relief that the possibility of the habit becoming fixed is all the greater.

Of the three methods of treatment, the abrupt, the rapid, and the gradual withdrawal of the drug, the last is recommended by the committee as the most suitable as it places less strain upon the patient and is unattended by collapse. Only 15 to 20 per cent of the addicts treated achieve a lasting cure. The experts declared that more successful results could be obtained if the United Kingdom possessed more institutions where special treatment was available which could be made compulsory for all addicts.—*Science Service*

Alcohols and Perfumes Made from Petroleum. The production of a refined and delicate perfume from ill-smelling petroleum was demonstrated by Harold S. Davis of the Arthur D. Little corporation before the American Chemical Society meeting at Tulsa. Recent investigations in this field indicate that the use of petroleum as a source of raw material for the synthesis of complex carbon compounds may in time transcend its importance as a fuel. Various alcohols may be made from crude mineral oils, none of which will interfere with the Volstead Act, but some of which have recently come into common use as solvents for lacquers and the like.

Among these alcohols that may be made from petroleum, that known to chemists as "tertiary butanol" is of particular interest and promise for industrial use as a consequence of certain unique chemical and physical properties.—*Science Service*

Chemical Digest

EDITORIAL PARAGRAPHS

Recently our attention was called to an editorial in *American Education*[1] which comments on an article appearing in *Scribner's*.[2] We strongly recommend the reading of the article in full and quote the following editorial comment:

> One of the best things in the *Scribner's* article is what Prof. Sherman says of the steady tendency of educational machinery to crush individuality in professors. The academic atmosphere is hostile to the professor who rises above the level of convention. A professor who presumes to hold opinions that are not in accordance with the prevailing notion of the College Administration is a standing menace to academic decorum, academic dogma, academic discipline, and the smooth functioning of the stenographers in the Dean's office, and must be crushed or ejected. No matter how eagerly a professor may yearn to say what he thinks instead of what he ought to think, he runs the risk of being crushed into educational insignificance.....
>
> Coming from a scholar who has shown himself one of the best balanced and most genial thinkers on literary and educational subjects in this country, what is said in the *Scribner's* article cannot be cast aside as the plaint of a disgruntled professor. Teachers in both college and secondary school should read these views of a writer who knows from first hand experience what goes on in the academic world. Truth from the inside is a good thing to have now and then.

The responsibility for teaching pupils to study must be definitely fixed in one department according to the *English Journal*.[3] The following comment is taken from that source:

> To blame high-school teachers for the shortcomings of the college freshman would be as unjust as it would be easy and useless. Many of the young people lack native intelligence and character in the amount required for good study. They are hopeless. The many who have the requisite character and capacity have not been cared for chiefly because what is everybody's business is nobody's. Departmentalism has led to an obsession with subject-matter and a consequent neglect of such general and unexaminable matters as methods of study. Some department must assume responsibility for teaching pupils to study or all departments must be aroused to genuine coöperation in the undertaking.

The Japanese are to be congratulated on the appearance of their chemical journal according to the editor of *Chemistry and Industry*.[4] His remarks follow:

[1] "The College Professor Again," *Am. Educ.*, **29**, 251 (1926).

[2] Stuart P. Sherman, "An Interview with a Newcomer in New York," *Scribner's*, **78**, 601–9 (1925).

[3] "Teach Them to Study," *English J.*, **15**, 232 (1926).

[4] "Chemistry in Japan," *Chem. and Ind.*, **45**, 19–20 (1926).

It is a pity that Japan has become as learned, as civilized, and as clever as we have become, and more artistic. It is a pity, but it is a fact. In the journal just read (*Japanese Journal of Chemistry*) we have transactions and abstracts, well printed in good plain type, most of the work in English, some in German, a little in French. The English is, on the whole, excellent. Most of it is better English than you will find in many of our own scientific text-books and journals....A rather hasty perusal of the abstracts leaves us thinking that they are very well prepared. They include only abstracts of chemical papers published in Japan, but these range over the whole field of chemistry from the electrolytic preparation of white lead, and the geometrical isomerism of isosafrol to the use of the hydrogen capillary viscosimeter. We venture to think that those workers in Japan on the geometric analysis of chemical compounds will have a more accurate perception of the meaning of centers of symmetry and axes and planes of symmetry than some critics in this country who consider that dissymmetry means two-fold symmetry. We fancy that the Japanese chemists are well aware that distasteful does not imply a two-fold taste, nor disorder a two-fold order. In some respects it is an advantage to write in a foreign language, as it often is to read in a foreign language. You cannot be slovenly while you are thinking what you ought to say. It is when your pen runs faster than your wits that you are led into obscurity of meaning.

The Journal of Education and School World[5] comments thus on research work.

That scientific research requires rare gifts of intellect and imagination may be regarded as axiomatic. But it is surprising that the proportion of students with first-class honors who are worthy of trial as research workers should be assessed as low as 20 per cent by Principal Sir James Irvine of St. Andrews University. Of these, only about five, he says, are worthy of further encouragement after two years' experience. Although the number of research workers able to make outstanding discoveries must necessarily be small, it must not be forgotten that their work is often the coping stone to a vast edifice of laborious experiment and observation, much of which can be accomplished by workers of inferior ability. Scientific research is not the only human activity to which the same principle applies.

The question of the exact purpose of a college education is again raised in an editorial on "Culture vs. Education?"[6]

I think that it will be generally admitted that a college course in chemistry should teach a student how to use chemistry as a tool, although it would be obviously impossible to teach him even a small fraction of the industrial processes he might encounter in actual practice. But the university should teach a man more than a mere "trade." That function belongs in technical high schools. It is astonishing how few chemists are really men of culture and refinement. The average college course in chemistry leading to the Bachelor of Science degree requires that the student devote at least three-quarters of his time to scientific studies, with the result that the graduate of such a course has had little opportunity in the university to study literature or philosophy or any foreign language beyond the easy minimum necessary to "get by."....Should not an interest in cultural subjects be given in high schools, with the result that even a chemistry student would be interested in reading good literature and hearing good music

[5] "Research Work," *J. Educ. & Sch. World*, **58**, 158–9 (1926).

[6] *Chem. Bull.*, **13**, 113 (1926).

or would at least maintain an intelligent interest in world affairs? The man of broad culture usually gets ahead faster, and in addition the language used in some of the scientific articles published might be greatly improved.

W. R. W.

FORTY YEARS OF EDUCATION*

In a recent issue of the *Forum*, under the above title, there appeared a symposium on education. In the words of the editor, "To celebrate our fortieth birthday *The Forum* has invited, from a wide possible choice, a group of modern leaders of education representing scattered localities or diverse points of view to look back over the past four decades and indicate some of the problems facing American teachers today as a result of the many changes in conditions and opinions that have come about during this period."

In the foreword, Agnes de Lima, speaking of the new philosophy of teaching, says:

> Children, so runs the new philosophy, are not empty vessels to be crammed with facts, but personalities to be developed. The school is not to be concerned with the child's mind alone, but with his physical well-being and emotional health as well. Prevailing methods not only do damage to intellectual power by destroying initiative and stifling thought, but they manufacture physical defects and sow the seeds for future emotional disorders.
>
> These truths are becoming widely established through the certain methods of laboratory research. As they gain wider credence, the schools gradually abandon first one and then another of their cherished traditions.....

John James Tigert in his article on "My Boy's Education and Mine" tells us that in his time education was measured exactly in terms of years—eight years for an elementary education, four years for a secondary education, and four years for a college education. He further says that it never seemed to occur to anyone that some might require a longer time, that others might require less, and that still others would benefit by an escape from this rigid system. In contrast to this, he writes:

> Beyond the vocational school we find the agricultural and mechanical college. The first of these institutions was established in Michigan shortly before the Civil War. Today every State in the Union has a similar institution, and agriculture and the mechanic arts have been established as an important part of our higher educational system. These institutions were greatly stimulated by grants of land and cash subsidies by the Federal government. In the past decade the property of these colleges has doubled and their income quadrupled. As my boy proceeds with his education, he will find an opportunity for culture beyond anything that was open to his father,

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* *Forum*, **75**, 442–51 (1926).

and likewise there will be at his disposal a machinery for vocational guidance unknown in my youth. If his interest and talents lead him in that direction he will be offered possibilities for vocational training which were never suggested to me.

Ernest Carroll Moore of the Southern Branch of the University of California writes on "Educational Alchemy." He says:

The men of my day were firm adherents of the dogma of formal discipline, but their great assumption that acquiring Greek, Latin, and mathematics enables one in some mysterious way to acquire more than these things has since then been subjected to experimental verification and is now known to be false. No reform has ever been effected in education that means so much as the attempt to drive the baneful doctrine of formal discipline from the schools.

In the article "In the Days of Discipline" by Arthur Ernest Morgan, we read:

Almost the outstanding impression of those early years is a sense of extreme loathing of that discipline. In the fourth grade, where I spent two years under the same teacher, this discipline almost reached perfection. The morning began with gospel hymns and a census of hand washing, teeth cleaning, and bathing, and then followed a day of perfect order. I could not help wriggling about at times, and in punishment spent many, many hours standing on my weary feet in the cloak room.....

Frank Ellsworth Spaulding on "The Passing of Great College Teachers" writes:

The development of American education in the last half-century presents no more marked and significant characteristics than these two, the great improvement in teaching in the public schools and the lamentable deterioration in teaching in the colleges. To the improvement in public school teaching must be credited in large measure the approximation to genuine universal education. It is the improved public schools that are causing the currents of universal education to rise ever higher until they are beginning to submerge the colleges. The latter have never exerted any positive constructive influence upon the movement for really universal education, having never expressed any genuine sympathy with this movement, except theoretically and on levels far below them. Small wonder that they gasp for breath as they find themselves submerging.

Of "The Vitality of the Early Home" Robert Ernest Vinson writes:

The school was looked upon as a useful adjunct to the home, but not a substitute for it. One could no more delegate his child's education to others than he could his religious training. Such responsibility was definite and inescapable. Of course, when college came, the children had caught up with the parents, so far as formal education went, but the stimulating spirit and companionship were still there, and one had by that time begun to sense the struggle and sacrifice of those earlier years, to sympathize with limitations which had not been self-imposed, and to feel something of the joy of sharing the larger advantages secured at such great cost.

The modern contrast to this is both evident and puzzling. Schools are so well equipped, teachers are so well trained, courses of study are so numerous and diversified, and methods are so constantly changing and withal always so new and different that the whole situation is nearly the reverse of that which I pictured. Then the school

was the adjunct to the home. Now it is the substitute for it, or at any rate, the two are not properly balanced. An enduring civilization could be built upon such homes as the one referred to, with or without schools, but it is to be doubted if it can be built upon an altogether institutionalized education, no matter how excellent, if such homes be lacking.

David Starr Jordan of Leland Stanford writes of "The Junior College." He says:

The value of higher education, even the possibility of it, lies in close relation to sources. The student should seek his own evidence and frame his own inductions. To teach any subject to huge classes, through informing lectures, is a waste of time of both teacher and student.

The lecture has two main values in education, and these are both of great moment. First, to bring together and coördinate the results of actual study, and second, to give inspiration for further research. Lectures should never be allowed to take the place of study.....

Universities under private control must find their special place amidst the "gigantism" of the State universities by stimulating and developing research and by undertaking intellectual advances, more or less beyond the scope of the State schools. These are bound to consider more and more closely the needs and wishes of the masses to whom they owe their support. The private institution should be the first to abandon purely elementary instruction, to take "the reluctant student" to the edge of the campus and drop him off, and devote itself to finding and developing the youth of special talents.

Regarding "Workers' Education" J. B. S. Hardman writes:

The educational mills, seeking to materialize the ideas of the upholders of the present industrial régime, turn out the kind of mentality which leads toward the perpetuation of the régime and of the mechanistic civilization in which it has culminated. This is as it should be. It is good logic that each prevailing order should seek to preserve itself. But labor is not in agreement with the prevailing industrial order. Whether conservative or radical, whether unwilling or ready to force a change, labor finds fault with things as they are. Labor wants "things" changed, and the labor ideal of education is one of education for social reconstruction and readjustment. The concomitant of the labor movement, workers' education, demands the type of education which trains such habits of mind in the workers as will help them to secure the desired changes in the social order.

In the final article of the symposium, "An Educational Credo" by Eugene Randolph Smith, we read:

My belief in the value of social science is particularly strong, and I am equally impressed with the need of general knowledge of natural science. It seems to me that as man's progress depends so largely on his mastery of environment and his acquiring the art of coöperating with his fellowmen, no one should come to maturity without a reasonably good basis for understanding and thinking in those two fields. I am equally certain that the right use of leisure and the enrichment of life depend on understanding and love for the arts, and I am sure that that love comes not from being driven through routine work in them, but from encouragement in appreciation of them and expression through them. I have no thesis against the classical subjects—certainly not against the study of modern languages—yet I often wonder whether the world would not be

much farther along if the Tower of Babel had never been built, and our children had, therefore, been left free to concentrate on the arts of living instead of, as is now too often the case, being forced to spend so much time on foreign languages.

W. R. W.

EDUCATION AS A SOCIAL FACTOR

Although one important function of education is to impart information and develop scholarly habits of thinking in students, character and personality must also be developed in order to preserve a balance between intellectual and social ideals. Success in social relations is essential to success in any line of endeavor. W. W. Charters[1] in a recent article writes: "My formula for success, in social relations at least, is this: Success in handling people equals two parts personality and one part brains. By the terms of this formula, I mean to indicate my opinion that personality is of more importance than information. This does not mean that information is negative in importance, for if the formula read, success equals two parts personality and no brains, the person to whom the formula would then apply would be what, in the language of the business world, is called a bluffer. He makes an excellent impression but is not effective. When, on the other hand, the formula reads, success equals no personality and brains, we have in mind the grind and the bookworm. Either extreme is bad. Over-developed social personality without a basic foundation of information is quite as ineffective as over-developed mental power and under-developed social efficiency. Both information and personality are necessary for successful living."

Mr. Charters goes on to say that "If we desire education to be a beneficial social agency, we must develop high ideals in the students. These ideals are developed partly through books and study. They are partly developed by personal contacts. It is the duty of every institution of learning to see that its students are provided with good books and with a strong faculty. Even in a large university it is entirely possible to provide every student with an adviser, selected to develop character and to assist the student in solving his personal problems. Much more remains to be done but the public which sends its children to the universities will be reassured in the knowledge of the fact that the importance of the problem of the development of character is fully appreciated by the administrative officers and by the majority of the instructors on the faculty."

On the other hand, social values may be made the criteria of educational values. This source of criteria has not been widely considered. David Snedden[2] writing on this subject says:

[1] "Education and Personality," *Univ. of Chicago Mag.*, **18**, 219–20 (1926).

[2] "An Unconsidered Source of Criteria of Educational Values," *Teachers' College Record*, **27**, 587–99 (1926).

"If courses and curricula for the various types of schools are to be derived scientifically rather than intuitively or empirically, they must rest upon *validated objectives*, that is, defined and tested educational values. But the value or 'worthwhileness' of any particular type or degree of education is necessarily based on *social values*—either explicitly determined, or, because of custom, implicitly assumed. It is obvious, therefore, that criteria or standards by which educational objectives are to be validated must be, in even more basic ways, criteria or standards of social values.

"Social values—'things of worth' to small or large societies, and to their individual members—are of a thousand kinds..... Many kinds of 'truest social values'—and especially the more deferred, intangible, and socially diffused—are perceived only by sagacious spirits and scientific minds.

"The possibilities of *offering* education seem, then, almost endlessly varied in kind and, within each department, degree of extent or excellency of attainment. Extensively proved or probable variabilities also prevail among those for whom the several types of education are designed—as respects educabilities, interests, and potentialities for putting their educational achievements to service. Perhaps, in the complexities of the modern world, no less variety exists as to the social needs to be served by education.

"Under these conditions it seems futile to argue 'the aim' of education. Hundreds, if not thousands, of valuable ends are to be achieved through those processes of controlled learning that we designate as education. At any given stage in the total scheme of school education for any given case-aggregate it may be possible to select one group of objectives that should be given primary consideration; but the attempt to do this over any extensive area seems as purposeless as to seek to discover which 'is more important, the brain or the stomach, the plow or the sword.' "

The following paragraph concludes his article:

"A realization of genuinely democratic aspirations for democratic education must be achieved through the application of 'making the most of each individual,' and not through trying to build on false assumptions as to inherent equalities (identities) of individuals, in native powers or potential areas of optimum usefulness."

W. R. W.

I do think that the study of natural science is so glorious a school for the mind that, with the laws impressed on all created things by the Creator, and the wonderful unity and stability of matter and the forces of matter, there cannot be a better school for the education of the mind.—FARADAY

ABSTRACTS

The Problem of Science Teaching in the Secondary Schools—A Comment. ELLIOT R. DOWNING. *Sch. Sci. and Math.*, **26,** 301–3 (1926).—A criticism of the article by R. A. Millikan which appeared in the November, 1925 (**25,** 966–75), issue of *School Science and Mathematics.* BEN. H. BALL

Must Science Go the Way of the Classics? NICHOLAS MURRAY BUTLER. *Genl. Sci. Quart.*, **10,** 499–502 (1926).—For some time past, the effort of educational systems and institutions has been expended upon the development of teaching and research in the natural and experimental sciences and in making provision for this work in men, in laboratories, and in apparatus. When this movement began, it was more or less stubbornly resisted by the college faculties of the day. Gradually the opposition to science study and science teaching broke down, and these new and highly important subjects were incorporated everywhere as part of the program of study from the elementary school through the university. The essential fact in all scientific study is the use and comprehension of the scientific method. Nothing is to be taken for granted and no test, whether quantitative or qualitative, is to be overlooked. Every conclusion as it is reached is held subject to the results of verification, modification, or overthrow by later inquiry or by the discovery of new methods and processes of research. There is little question that the decline in interest and authority of the ancient classics as educational instruments was hastened by, and was in no small part due to, the manner and method of teaching those subjects that became substantially universal about sixty years ago. "If one desires to be a physicist, a chemist, or a biologist, and is ready and willing to devote his time and his energy to that end, then the methods now in vogue in the colleges and universities are excellent. If, however, one wishes to know what physics, chemistry, and biology are about, how they came into existence, what has been their history, who have contributed in most important fashion to their advance, how they are related to each other and to other branches of knowledge, and what is the significance of their present conclusions and applications, then he will find it very difficult indeed to get guidance or help from any teacher of physics, of chemistry, or of biology. In fact, many of these teachers do not possess this sort of knowledge....The making of a few score of admirable specialists, the training of a few hundred research students and the annual production of a small army of youth with narrow, if minute, information useful in some particular vocation, is a sorry substitute for reaching the great mass of the population with the influence and the ideals of scientific inquiry and scientific method." W. R. W.

Too Much Schooling. E. T. GOOD. *English Rev.*, **42,** 350–7 (1926).—The author states that a change in the educational system is necessary. He suggests, "that the ordinary curriculum be cut down by half; that the compulsory school age be reduced; that children obviously unfitted for advanced school education be liberated at an early age; that educationally bright children be given all the state can give; that teachers concentrate on small classes of selected scholars instead of wasting so much time on those without aptitude for high standard schooling; that we think more about promoting industrial skill and kitchen knowledge than classical scholarship; that, at all events, we cease trying to impose excessive schooling on minds unsuited for it." In trying to make scholars of all children we not only handicap the educationally quick-witted by too much association with the dullards, and by causing the teachers to devote their main attention to the dullards to the neglect of the quickwits, but we put the educationally dull children out of love with everything labeled education. We make them dislike, if not detest, learning and, incidentally, we keep them out of line with occupations which, otherwise, they would be eminently fitted to undertake. Our secondary schools and training colleges for teachers are the worst parts of our educational system. In these institutions little seems to matter but a capacity for imbibing book knowledge and passing written examinations according to pedantic ideas. Young men and women who have passed through all this with distinction, and are in many cases given the work of teaching our children, are densely and appallingly ignorant of the world, its industries and institutions, and of the common wants of the people. Their logic, their reasoning faculties, their power to grasp a conversational point, their ability to express themselves on paper are mostly very poor. "Not more than one Englishman in ten can talk intelligently on any serious problem or subject. His intelligence is strictly limited to what he calls sport. The majority spend their time studying betting odds and football. The minority indulge in frothy agitation. The nation, in bulk, has no mind for either intellectual study or serious work. Our schooling system is at the bottom of the trouble—a trouble which imperils the

future, even the existence of England. It is time for an educational profit-and-loss account—and for a drastic change." W. R. W.

A Half Century of Chemical Education. J. N. TAYLOR. *Genl. Sci. Quart.*, **10**, 480–91 (1926).—A biography of Charles Edward Munroe, Director and Chairman on Explosives Investigations, National Research Council, and a bibliography of his writings. W. R. W.

Teaching Science vs. Teaching Facts. LOWELL C. FROST. *Genl. Sci. Quart.*, **10**, 412–5 (1926).—"The teaching of factual information is the easy road to a salary for the weak teacher. It is dangerously simple to assign four pages in the text, and to check off the ability of each pupil to remember the items of information contained therein. But the method is really self-defeating, for too great stress upon the remembering of facts is almost certain to leave them unrelated to each other and to thought processes. And it is common experience that an unrelated fact is a fact lost to memory.

"It would seem, then, that the true function of a teacher of science is to inculcate in the pupil the habit of using thought effectively in dealing with facts. The pupil may get the facts from a few good books, but he will not get the habit of straight thinking about them from few or many books. He must have a real teacher if he is to comprehend real science."

Certain general assumptions in the teaching of science, although widely accepted, are seldom clearly expressed. The author lists the following as the more important ones:

1. Scrupulous maintenance of a scientific attitude on the part of the teacher, and avoidance of "scientific" dogmatism.
2. Complete and accurate expression of every statement, question, and answer of both teacher and pupil.
3. Utilization of every opportunity to ask "why?"
4. Adequate presentation of the fundamentals of logic in every science class.

That the child's mind is inherently more logical than the mind of an adult is a fact observable and provable by anyone. That we allow it to remain a fact is the most terrifying indictment of our educational system. W. R. W.

A Lesson in Osmosis. JOHN V. JEWETT. *Genl. Sci.-Quart.*, **10**, 400–1 (1926).—There is always difficulty in presenting the subject of osmosis to a class. The usual method of demonstrating with a piece of membrane or parchment stretched across a thistle tube is frequently interfered with and unsuccessful because of breakage and leaks. The following method avoids any possibility of error, and the apparatus, present in the poorest equipped school-room, can be quickly and easily set up.

Use a 1000-cc. beaker with a medium-sized funnel held upright in the beaker by inserting it into a rubber stopper. A piece of parchment is placed in the funnel in the same manner as a filter paper. This will hold the denser solution and is transparent enough to permit the class to see the solution before, during, and after the demonstration. Warm water should be used in the beaker and a thick, warm solution of Karo syrup, colored with red or black ink, in the parchment. In this arrangement there is no possible suggestion of anything but the passage of warm water through the parchment because every part of the apparatus is before the eyes. After the sirup has been placed in the parchment the class can see that there is no chance for leakage. W. R. W.

Science Meeting Tomorrow's Needs. B. CLIFFORD HENDRICKS. *Genl. Sci. Quart.*, **10**, 397–9 (1926).—The interest of high-school boys and girls is in the future. The morrow is going to make a greater demand upon its men and women to get on pleasantly with their fellows. Students in high schools and colleges will study chemistry and other sciences to learn of the results of the work of scientists who are members of the various science organizations of this country. As the population grows, the food supply will become more and more of a problem. The chemist sees it from three angles: a need for increased natural production, which means a greater use of fertilizers; more attention to and care in preventing waste, with means developed for use of all waste as foods are now handled; improved and successful methods of producing synthetic foods in the laboratory. Increased population also brings a greater danger from infectious diseases. This means a demand for medicines whose action is swift and certain. This is a field in which chemists are now working industriously. All this serves to point to a great need in our training for life in this tomorrow—a need for a safe, dependable method of attacking and solving problems of food, medicine, and power as well as others involving social, economic, and similar relations. The scientist always proceeds in a well-ordered manner as he seeks to unravel the perplexities that confront him. This mode of attack has brought about such results for the scientists that the scientific method is now being used in the teaching in history, sociology, edu-

cation, and allied fields. This is undoubtedly a method that should be well understood by the citizen of tomorrow. W. R. W.

What Shall We Educate For? BETRAND RUSSELL. *Harper's*, **911,** 586–97 (1926).—Various educational systems have different aims in view. The Greeks devoted their energies to art and science and mutual extermination. The Chinese education produced stability and art; it failed to produce progress or science. Modern Japan affords the clearest illustration of the tendency which is prominent among all great powers—the tendency to make national greatness the supreme purpose of education. England's aim was to train men for positions of authority and power, whether at home or in distant parts of the empire. The American public schools achieve successfully a task never before attempted on a large scale; the task of transforming a heterogeneous selection of mankind into a homogeneous nation.

The author lists four characteristics which in his opinion jointly form the basis of an ideal character; vitality, courage, sensitiveness, and intelligence. Vitality promotes interest in the outside world; it also promotes the power of hard work. The perfection of courage is found in the man of many interests, who feels his ego to be but a small part of the world, not through despising himself, but through valuing much that is not himself. This can hardly happen except where instinct is free and intelligence is active. Sensitiveness, the third quality in the list, is in a sense a corrective of mere courage. Courageous behavior is easier for a man who fails to apprehend dangers, but such courage may often be foolish. Any way of acting which is dependent upon ignorance or forgetfulness cannot be regarded as satisfactory. The fullest possible knowledge and realization are an essential part of what is desirable. One of the great defects of traditional morality has been the low estimate it placed on intelligence. Intelligence includes both actual knowledge and receptivity to knowledge.

"A community of men and women possessing vitality, courage, sensitiveness, and intelligence in the highest degree that education can produce would be very different from anything that hitherto existed.....poverty, since the industrial revolution, is due only to collective stupidity. Sensitiveness would make people wish to abolish it, intelligence would show them the way, and courage would lead them to adopt it."

W. R. W.

What Laymen Are Saying about Education. BY THEMSELVES. *Educ. Rev.*, **71,** 179–89 (1926).—Under this head a number of quotations are given from leading newspapers on the subject of education. In the *Educational Review* for January the Superintendent of the Chicago Public Schools wrote: "In 1870 there were on the walls of the schools north of Mason and Dixon's line a noticeable number of pictures of battle scenes and generals. General Robert E. Lee was represented in most southern schools. Later the familiar Spirit of Seventy-Six was a favorite. I haven't seen it in a schoolroom for over ten years." Two months after this was written the *Chicago Tribune* ran a "story" on its front page to the effect that the Superintendent of Schools says that the Spirit of Seventy-Six is bad in schools and if he has his way it will be outlawed from the school-rooms, etc.

Other comments are on Negro Education and Opportunity by tke *New York Times;* Optimism as to Education, *Los Angeles Times;* Training the Bright Child, *Kansas City Star;* Harnessing the Community to the School, *Public Ledger;* Never Too Old to Learn, *Despatch of Union, N. J.;* School for Fathers, *Cleveland Press;* Who Is Responsible for College Failures? *Washington Post;* Married Women as Teachers, *New York Times;* Who Shall Make the Course of Study? *Public Ledger;* Laymen on the Course of Study, *Washington Post;* Fool Spelling Matches, *Kansas City Star;* Organized Parental Help, *New York American;* New York's Opinion of Its High-School Pupils, *New York Times;* Public Schools Are Superficial and Neglect Fundamentals, *Boston Evening Transcript;* and Health Service without Elaborate Organization, *Chicago Daily Journal.*

W. R. W.

The Mysterious I. Q. HARLAN C. HINES. *Scribner's*, **79,** 155–62 (1926).—During the past few years there has grown up in America a strong tendency to card-index every man, woman, or child. It has been a familiar movement in business and industrial enterprises for some time, but more recently it has found a place in our schools. In the schools where the movement has had its greatest effect, the interest in the standardization of training has made it seem necessary to measure the intelligence of the children. Since the schools are dealing with the big problem of creating constructive thought, it is important to know how much intelligence each child has, so that teachers may build on from there and thus permit the child to attain its highest possibilities.

American intelligence testing is directly traceable to Binet and Simon, two Frenchmen, one a psychologist and the other a physician, who, in 1905, devised an intelligence

scale that was to have far reaching consequences. In 1913, Prof. Lewis M. Terman, a psychologist at Stanford University in California, began a revision of the Binet scale for American use.

"In spite of objections raised, there is a value that has accrued from the giving of intelligence tests that should not be overlooked. Aside from the fact that the teacher, as never before, is forcibly reminded that children differ from each other as minutely as blades of grass and that their conduct from day to day is as subject to change as New England weather, actual sub-normal cases have been located and, in instances of definite feeble-mindedness, much good has been accomplished by a special type of training that makes the ordinary achievements of life much more possible.

"Psychologists and educators have been engaged in a much prolonged argument over the definition of intelligence. While no actual blows have been struck, there has been much mental violence, which, though at times distressing, has done much to clarify the atmosphere and bring this mystifying problem down to simple terms. Strange as it may seem, the definition of intelligence could not be formulated until intelligence was measured."

The organization of parent-teacher associations in thousands of cities and towns throughout the country is highly commendable. If all parents who have children in attendance at school would become members of such organizations, they would be afforded the opportunity of hearing problems of school administration and class-room management discussed. The subject most frequently presented is one which has some bearing on the meaning of the mysterious I. Q. W. R. W.

Should Scientific Research Be Rewarded? J. B. S. HALDANE. *Discovery*, **7**, 65–6 (1926).—Since the wealth of modern societies is, in a large degree, the creation of scientific research it is suggested that scientific workers should share in this wealth on a scale more or less comparable with that on which labor and capital are rewarded.

"A scientist can practically never hope to earn as much as £2000 per year as such, and is generally glad if he gets half that sum, while incomes of £300 are quite common. To make more he must go out of the path of pure research and teach, and apply his talents to industry, administration, popular writing, or some other activity for which there is an economic demand.

"The French, for example, do not pay their men of science a living wage. On the other hand, they give them statues—often very good statues—when dead, and call streets after them and to many scientific men, such is our perversity, the prospect of becoming a street name is a better incentive to effort than a rise of salary."

Scientific discovery should be paid for on a system of credit rather than of cash down. At present, research in pure science is mainly performed by professors and lecturers at universities in the intervals of the teaching and administration for which they are paid. The author mentions among men who have not been sufficiently paid for their contributions to science Banting and Macleod, winners of the Nobel prize, Willard Gibbs as the father of modern physical chemistry, and Moseley whose law connecting the X-ray spectrum of an element with its atomic number has aided greatly in the discovery of new elements. The author further adds that it is not only unjust but contrary to public interest that scientific research should be, as it is, the worst paid of all the intellectual professions. W. R. W.

Aniline Dyes in the Treatment of Infections. JOHN W. CHURCHMAN. *Clin. Med.* **33**, 153–8 (1926).—Aniline dyes were introduced and tested clinically on a large scale during the war and stood the test sufficiently well to warrant further study of their possibilities. Laboratory workers in recent years have been engaged in investigations of the dyes and their work has led to an important advance in the treatment of infections.

By employing aniline dyes either through incorporation in the media upon which bacteria are planted or by methods of vital staining, investigators in the laboratory have been able to throw new light on the fundamental mechanism of antisepsis. A valuable property of the dyes is their selective power or adaptability to the particular organism responsible for the infection. They also have the power to inhibit, even in high dilutions, the growth of bacteria. Another property of the dyes which has attracted attention to them is their power to penetrate tissues, a power which most of the commonly used antiseptics do not possess. The dyes are also relatively non-injurious. The most widely employed dyes have been acriflavine, Gentian violet, mercurochrome, and acriviolet. W. R. W.

Need for Research on the College Curriculum. WENDELL S. BROOKS. *Sch. and Soc.*, **22**, 692–6 (1925).—Research is needed because conditions within the college have changed, students come from more widely distributed homes, faculties are different,

equipment is costly, success of democracy depends upon education of the masses and scientific measurements, so successful in the secondary field, must be applied in the college field. SY

The College Entrance Examination Board. WILSON FARRAND. *Sch. and Soc.*, **22,** 601–7 (1925).—A brief history of this board. First suggested by President Eliot in 1877, actually started in 1900 by a committee of which Dr. N. M. Butler was chairman. In 1901 fifteen colleges belonged to this board; there were 39 readers and 973 students took the examination. In 1925 there were 35 colleges represented, 600 readers, and about 20,000 students examined. The work of this board is the most striking example of educational coöperation this country has ever seen. It also tends to maintain standards of attainment in our high schools and for admission to college. The board is constantly studying and improving its methods. SY

The High School's Interest in Methods of Selecting Students for Admission to College. WILLIAM M. PROCTOR. *Sch. and Soc.*, **22,** 441–8 (1925).—Mention is made of the increase in attendance at high schools and the correspondingly greater enrolment at colleges. The latter have been forced to adopt protective measures to keep out poorly prepared students by raising the entrance requirements and fees. The College Entrance Examination Board method for selecting students is criticized because no simple examination of the essay type gives a fair sampling of the candidates' knowledge in a given field. Another weakness is the personal equation of the marker which introduces an element of chance. Another method of admission is by certificate from accredited high schools. The New England College Entrance Certificate Board judges a high school by the record which students from that high school make in college. A serious defect of this plan is that it takes no account of the native ability of the pupil. When high schools are accredited after an inspection the danger lies in the fact that the inspecting agency has the power of dominating over the high school. Another plan, that of considering a superior high-school record alone, has the weakness of making high scholarship alone a criterion for college admission. The proposed method for college admission includes a scholarship rating based on all high-school marks, the Thorndyke I. T., or its equivalent, and a standardized scale for rating character traits. SY

When the Chemistry Teacher Taught English. STEPHEN G. RICH. *Educ.*, **46,** 352–8 (1926).—The writer of this article, a teacher of chemistry and biology in Concord State Normal, was forced, in an emergency, to do some instructional work in the English department of the same institution. The observations and conclusions of this unique experimenter are related. Dr. Rich believes that the teaching of English could be made more effective if the methods of teaching, as used in the experimental sciences, were followed more closely. The lectures and laboratory exercizes of the exact sciences may have counterparts in properly designed exercizes in the English course. This procedure diminishes the vagueness in the student's mind by giving him more concrete conceptions. It is also predicted that the chemistry teacher may have much to learn from the English department. O. J. S.

Recent Technical Bibliographies. RAYMOND N. BROWN. *Libr. J.*, **51,** 232–6 (1926).—The list includes the more important bibliographies that have come to the attention of the compiler at the Engineers Society Library during 1925. Of most interest to chemists is the Bibliography of Bibliographies on Chemistry and Chemical Technology, 1900–1924, by C. J. West and D. D. Berolzheimer, *National Research Council Bulletin* **50,** 308 pp. (March, 1925). References are arranged by subject. O. J. S.

The Nature of Active Nitrogen. M. DUFFIEUX. *Nature*, **117,** 302–3 (1926).—Duffieux has made an extensive study of active nitrogen and finds that his data support the hypothesis that active nitrogen is atomic nitrogen. The band spectra are given but, contrary to most spectroscopists, Duffieux thinks that the bands are due to atomic nitrogen and gives his reasons. He further points out that the parallelism between the observations by Wood on atomic hydrogen and Strutt on nitrogen is complete. H. K. M.

Criteria of a Standardized Test. G. M. WILSON. *Educ. Rev.*, **71,** 138–41 (1926).—The test should be in harmony with and reinforce the right curricular principles; it should encourage, supplement, and reinforce proper methods of teaching; and it should serve the true purposes of an examination. A good examination is the best teaching which can be done at the time and provides for a new view, a reorganization, or a worthwhile application. As examinations are means and not ends, secondary or minor criteria should be added to make the test more valid, more accurate. The reliability and objectivity may be increased and the test should be economical and convenient and, therefore, as useful as possible. There is ample discussion and the teacher is

urged to become more critical of tests and thus aid in the general work of making them more acceptable by more nearly serving the larger aims of the subjects and of education in general. H. K. M.

The Negative Suggestion Effect of True-False Examination Questions. H. H. REMMERS AND E. M. REMMERS. *J. Educ. Psychol.*, **17,** 52–6 (1926).—Two groups of students, 68 in each group, were given 121 questions on a new passage in reading, previously assigned. First, one group took the recall, the other group the true-false questions. One month later the first group took the true-false and the other group the recall questions on the same passage of reading. It was concluded that, with the kind of material and subjects used, the objection frequently raised against true-false questions based on the old pedagogical maxim that false associations are detrimental was disproved, since there was no evidence of negative carry-over from the taking of true-false examinations. As between the two types of tests used in this experiment, the initial application of true-false tests seemed to slightly favor delayed recall. Also, the scores on completion tests were significantly higher than on the true-false when the latter are corrected for guessing. W. G. K.

Plowshares from Chemistry's Swords. D. H. KILLEFFER. *Ind. Eng. Chem.*, **18,** 253–8 (1926).—To supply the enormous need for smokeless powder during the World War, three large plants were built: at Hopewell, Va., by the du Pont Co.; and at Nitro, W. Va., and Old Hickory, Tenn., by the Ordnance Department of the U. S. Army. The author describes the sites of these installations, considering seven important factors (besides defensibility), which make a factory location desirable. These are availability of raw material, proximity of markets, labor supply, power supply, water, waste disposal, and transportation facilities. Following the war the plants closed due to cessation of the demand for smokeless powder, but the desirability of the sites has led to establishment of other chemical industries thereon. Most of the original equipment was scrapped, rather than used in the new industries, the magnitude of the installations rendering salvaging profitable. Kraft paper, and the products made from partially nitrated cellulose, are the chief manufactures at present. The author emphasizes the startling fact that no provisions whatsoever have been made to revert to the production of smokeless powder, should national emergency require it. V. R. THAYER

Systematic Outline of Chemical Literature. M. G. MELLON. *Chem. and Met. Eng.*, **33,** 97–8 (1926).—M. presents a classification of the sources of chemical literature. Since the outline is designed as a basis for instruction in the use of chemical libraries, it is based on the nature of the publications rather than on the technical division of the subject-matter. Material which has appeared since 1665 is considered. Sources are classified as original (unorganized) information, and secondary (organized) information. The former is divided into periodicals, contributions of institutions, literature on patents, and miscellaneous. The secondary sources consist of periodicals and serials, bibliographies, general works of reference, and text-books. For detailed study, expansion of various units of the outline on a basis of technical subject-matter is recommended. V. R. THAYER

Detection of Methanol in Alcoholic Beverages. F. R. GEORGIA AND RITA MORALES. *Ind. Eng. Chem.*, **18,** 304–6 (1926).—An extensive investigation was conducted to find a simple, rapid, and sensitive procedure for the determination of methanol, which would be effective in the presence of ethyl alcohol and substances derived from the latter during the test. Methods are classified as follows: those depending upon physical constants; those involving chemical reactions other than oxidation; those involving oxidation and subsequent detection of the oxidation product. The determination of methanol by measurements of the refractive index is considered accurate for mixtures containing at least 5% wood alcohol. Methods in the second group are either unreliable or very complicated. The procedure approved by the authors involves oxidation of methanol to formaldehyde by means of potassium permanganate in phosphoric acid solution; destruction of excess permanganate with oxalic acid; and detection of formaldehyde through color test with Schiff's reagent. Preliminary removal of formaldehyde (before oxidation) is done with sulfuric acid and pyrogallol. Directions are given for removing numerous interfering substances, such as amyl alcohol, essential oils, glycerol, resorcinol, and others. No suitable method was developed for removing methyl acetate, oil of angelica, and pectinous material, all of which give positive reactions with Schiff's reagent, after oxidation. V. R. THAYER

Vitamins in Canned Foods. V. Peaches. EDWARD F. KOHMAN, WALTER H. EDDY, VICTORIA CARLSSON, AND NELLIE HALLIDAY. *Ind. Eng. Chem.*, **18,** 302–3 (1926).—Five lots of canned peaches, each prepared for packing by a slightly different method, were compared as to vitamin content with raw and with "home cooked"

fruit, by the usual method of feeding to guinea pigs. After being kept for a stated period on a diet free from the particular vitamin studied, the pigs were fed measured amounts of peaches, and the effects noted with regard to growth, and prevention or alleviation of scurvy. The canned fruit compared favorably with the raw in vitamin content. "Home cooked" peaches appeared to contain only one-fourth as much vitamin C as canned peaches. The latter contain about one-third as much vitamin A as butter fat. Quoting from previous articles of their series, the authors state that apples from which the oxygen has been removed by the respiratory process, suffer no loss of vitamins through canning; that peas undergo relatively little loss in vitamin C, when canned, as compared with cabbage and spinach; and that available data on canned tomatoes are inconclusive. V. R. THAYER

Manganese and Plant Growth. J. S. MCHARGUE. *Ind. Eng. Chem.*, **18,** 172–4 (1926).—Following detection of manganese (as well as copper, zinc, boron, barium, strontium, iodine, and arsenic) which occurs in small amounts in plant ash, an investigation was conducted to determine positively the importance of manganese for plant growth. Exhaustive precautions were necessary to insure that no manganese was contained in the sand used for the bulk of the artificial growing medium nor in the compounds of the ten elements added thereto. These substances, formerly considered to be the only ones essential to plant growth, are: carbon, hydrogen, oxygen, nitrogen, phosphorous, potassium, calcium, magnesium, sulfur, and iron. The plants were raised in special acid proof stoneware jars, and comparisons were made between those grown in soils with and without manganese. The author concludes that the latter element is fully as important as iron for the formation of chlorophyll and that both are indispensable for the growth of plants. V. R. THAYER

Status of University Students in Relation to High-School Courses. WILLIS W. CLARK. *J. Educ. Res.*, **13,** 36–8 (1926).—Scholarship records of 369 freshmen in the University of California, Southern Branch, were examined to determine the influence of certain specified preparatory courses upon the scholastic achievement of these students. The specified courses are representative of the usual entrance requirements of class A colleges. A tabulation of the mean college grade in relation to completion of required preparatory units shows for students who had completed the units a slight tendency to a better average grade at the end of the semester. A tabulation of the per cent of college units passed in relation to the completion of required preparatory units shows that the 203 students who had completed these required units passed 93.3 per cent of the college work attempted, whereas the 166 students who had not fulfilled the requirements passed 89.7 per cent of their college work. It is shown that for purposes of prediction the very slight superiority of the students who had completed the required units is practically negligible. R. M. P.

What We Are Failing to Measure in Education. HERBERT A. TOOPS. *J. Educ. Res.*, **13,** 118–28 (1926).—Prediction being the primary purpose of capacity tests, the author suggests economical sources of material easily available for determination of mental capacity that would serve to better advantage than the tests usually given. The total records of pupils from the grades give a more valid basis for prediction of work in high school than do the mental tests. The cumulative college record at the end of the first year has been found to foretell the subsequent career of the student until graduation with a high degree of accuracy.

The author sets forth some of the as yet unmeasured unique traits which function in the school situation. Nineteen such traits are listed, among them being social capacity, moods and emotions, psychopathics, metabolism, health, ossification, music-rhythm, self-sufficiency, etc. A study of these numerous qualities would require coöperative research upon the same group of test subjects, or pupils, by workers in the various fields designated, using standard measures and procedure. R. M. P.

Will the Teacher Become an Extinct Species? J. F. MARSH. *Sch. News,* **39,** 51–2 (1926).—Teachers may do well to consider fossils of the past and certain animals of the present. Extreme types as illustrated by the dinosaur, the peacock, and the heavy-wooled sheep may endure only if protected from animals that persist in playing a rough game. The question arises as to whether teachers should specialize to the extent of placing themselves at the mercy of the ordinary forces of society, or should they maintain social qualities that will take them into various groups to learn the ways of life. The author believes in proper specialization but not to the extent of permitting retrogression of the individual in social, physical, and economic interests. R. M. P.

Standards of Living and of Educating. JOHN H. NORTON. *J. Educ. Res.*, **13,** 22–35 (1926).—A compariosn of the *dollars* spent in education in the years 1914 and

1924 shows an increase of 226 per cent. The author suggests a method whereby the measure of school expenditures may be made in terms of the purchasing power per unit of service rendered. The provision of one day's schooling for one elementary school child is proposed as the unit in measuring the amount of educational service provided in successive years. Each day's schooling for a high-school pupil is weighted by multiplying that of the grade-school child by two and a half in computing the total amount of service rendered. As the basis for arriving at the purchasing power of the dollars spent by school-boards, the index of the "cost of living" is use, although an index of the "cost of educating" would be preferred were it available.

In 1914, 22.4 cents were expended for each unit of school service whereas the corresponding figure for 1924 is 46.3 cents. However, the dollar of 1914 had depreciated to 61 cents in purchasing power in 1924. Thus, sixty-one per cent of 46.3 cents gives 28.2 cents as the purchasing value expended for each unit. The apparently tremendous increases in expenditure are largely overbalanced by the rapid increase in school attendance especially in the upper and more expensive levels, and by the depreciating power of the dollar. The author shows the increase in purchasing power of money expended in 1924 above that in 1914 to be only 26 per cent. Accordingly, boards of education were no more able to maintain efficient schools in 1924 than in 1914.

A strong argument is presented in favor of federal aid to education because of its importance to national welfare. Five tables and two figures are included which are of value in scientific analysis of school budgets. R. M. P.

Nutritive Value of the Protein in Veal and Calf Sweetbreads; in Beef Cheek Meat, Lips, Tongues, Brains, Spleen, and Tripe; and in Hog Brains and Tongues. RALPH HOAGLAND AND GEORGE G. SNIDER. *J. Agr. Res.*, **32**, 687–8 (1926).—"The poor quality of the protein in sweetbreads and tripe is presumably due to a deficiency of one or more of the essential amino acids, but information as to the nature of these deficiencies is lacking. The low nutritive value of the protein in beef cheek and ox lips is undoubtedly due to the presence of considerable connective tissue, which is known to be lacking in several essential amino acids. The low value of casein, when fed at the 10 per cent level, is due to its well-known deficiency in cystine. This deficiency is made up, however, when casein is fed at a level of 18 to 20 per cent, and optimal growth then results.

Although the proteins in sweetbreads, tripe, beef cheek meat, and ox lips were found to be of relatively poor quality when any one of these products constituted the only source of protein in the diet, it is possible that the deficiencies of these proteins may be made up when they are in combination with other animal or vegetable proteins." J. W. R.

Inactivation of Vitamin A by Rancid Fat. WILMER C. POWICK. *J. Agr. Res.*, **31**, 1017–26 (1925).—Three experiments with rats bearing upon the characteristics of rancid lard as a food are reported. The lard used was more intensely rancid than would anywhere have been tolerated for human consumption, and probably more rancid than would be acceptable for animal feeding. It was also employed in larger proportions than those in which fat is generally used in the rations of man or beast.

Under the conditions of these experiments, rancid lard, though clearly inferior to sweet lard as a ration component, did not seem to be actually toxic to the white rats receiving it.

The inferiority of rancid lard as a food product appeared to be due to its ability to destroy the vitamin A of the rations with which it was admixed. This destruction appeared to occur gradually over a period of several days, and was presumably due to the oxidation of the vitamin A by the organic peroxides of the rancid lard.

When the vitamin A was fed separately from the lard, the males receiving the rancid lard seemed to require more vitamin A than did males receiving a corresponding ration containing sweet lard. J. W. R.

Effects of Feeding Animals with Trichinous Meat Containing Nonviable Trichinae. BENJAMIN SCHWARTZ. *J. Agr. Res.*, **31**, 945–7 (1925).—"Rats, dogs, and cats were found to be tolerant of heavy doses of meat containing nonviable trichinae, exhibiting no ill effects as a result of repeated ingestion of such meat. These observations are in harmony with the generally accepted view that pork in which trichinae have been destroyed by cooking or by some other method known to devitalize trichinae will not produce any of the symptoms characteristic of trichinosis or other harmful effects." J. W. R.

Vitamin A in Beef, Pork, and Lamb. RALPH HOAGLAND AND GEORGE G. SNIDER. *J. Agr. Res.* **31**, 201–23 (1925).—The samples of beef tested were relatively poor in vitamin A, but when used in rations in proportions of 50 to 95 per cent, nearly sufficient

vitamin A for normal growth was furnished. The results of the experiments with fresh pork show that the samples tested were relatively poor in vitamin A.

The results of the vitamin A tests with lamb show that three of the six samples examined were rather poor in vitamin A, one contained a fair proportion, while the remaining two samples were richer in vitamin A than any of the samples of meat reported in this paper. J. W. R.

Cleaning Milking Machines. L. H. BURGWALD. *J. Agr. Res.*, **31**, 191–6 (1925).—Comparative tests of the three methods commonly used for sterilizing milking machines—namely, heat, chloride of lime, and a mixture of common salt and chloride of lime—showed that the heat method, under conditions as nearly identical as possible, gave more uniform and appreciable lower bacterial counts than did the other two methods.

The experiments indicated that making up a fresh sterilizing solution of chloride of lime, or of salt and chloride of lime, once a week in cold weather, would undoubtedly be sufficient to insure a good grade of milk if the units were thoroughly washed and the solution kept free from all foreign matter. During warm weather, however, fresh chloride of lime solution should be made daily, even under the most cleanly conditions; and new salt and chloride of lime solutions should be made up about every other day. J. W. R.

Super Sublimed White Lead. J. H. CALBECK. *Trans. Am. Inst. Chem. Eng.*, **16**, 13–27 (1926).—In order to meet the enormous demand for pigments for ready mixed paints, a method was devised to prepare a basic lead sulfate ($PbO.2PbSO_4$) by burning droplets of lead in an atmosphere of SO_2, S, and O_2. The product consists of very finely divided particles which are exceedingly white, more so than even titanium oxide, French process zinc, or lithopone. It is also brighter than any of the above pigments. Its behavior in linseed oil and its covering power are equal or superior to any other lead pigment. G. B. HEISIG

Future Gas Supply—A Challenge and an Opportunity. W. M. RUSSEL. *Trans. Am. Inst. Chem. Eng.*, **16**, 195–200 (1926).—The increasingly large use of gas for heating purposes will cause the gas engineer to consider the problem of the process and the supplies of raw material to be used. The manufacture of gas by the distillation of coal in retorts or by-product coke ovens will not solve the problem on account of the limited market for by-product coke. On the other hand, the producer of carburetted water gas is confronted with the problem of securing cheap raw materials. The price of gas oil is rapidly increasing and will increase more rapidly in the future because the oil can be converted into gasoline by various cracking processes now in use. The cheaper grades of coke have replaced anthracite but the price of coke is constantly increasing.

The author believes that the ideal process for making gas should utilize bituminous coal. The coal should be converted to coal gas and water gas leaving only ash and clinker. The heat evolved during the process should be conserved. The gas should be enriched by the use of a heavy fuel oil. The entire process should be automatic and should require a small amount of labor. G. B. HEISIG

University Takes Over Evening Courses. ANON. *Chem. Bull.*, **13**, 68–9 (1926).—"Beginning with the spring quarter 1926, University College of the University of Chicago offers, in coöperation with the Chicago Section of the American Chemical Society, a course in Chemistry; Special Topics of Chemistry, Physical, Organic and Inorganic." This is to be an evening course and university credit will be given those desiring it, though others not seeking such recognition are quite as welcome to its offerings.

A symposium of estimates of the value of such a course is printed under the signatures of such men as: H. E. Barnard, Emery Filbey, W. Lee Lewis, Hubert N. McCoy, W. D. Richardson, Frank C. Whitmore, F. W. Willard, and Robert E. Wilson. Nothing but words of approval are voiced in these letters. B. C. H.

Achievements of American Chemists. W. A. NOYES, JR. *Chem. Bull.*, **13**, 67 and 75–6 (1926).—Processes, it is said, are usually developed by slow degrees and are by no means spectacular during evolution. The discoverer of a principle is often dead before the principle has borne fruit in industry.

The sole object of research is not ultimate industrial application. Investigation seeks quite as often to learn of the world's interesting things about us, generally, with no great concern for the economic worth of what is found. Such research, however, sometimes proves of industrial value in quite unexpected ways.

In the field of metallurgy, C. M. Hall and his work in reducing aluminum is given. Charles Goodyear's work with rubber with Frasck's method of mining sulfur are followed by an account of Remsen's saccharine and Kendall's thyroxin. Abel's isolation of

adrenaline and Banting's preparation of insulin are included. Helium gas is presented, some of its merits for ballooning cited and Doctors Cady and McFarland given credit for finding it in natural gas. Synthetic resin is next listed to America's credit with Baekeland its chief sponsor. Bare mention is made of America's development of good optical glass, her improvement of paints, her emancipation from German dyes, her production of artificial silks, and making radio-active substances marketable.

B. C. H.

Graduate Student Assistants and Graduate Work of Students, Committee E. *Bull. Am. Assoc. Univ. Profs.*, **12**, 100–14 (1926).—A report based largely upon questionnaire returns from 256 individuals. Among the outstanding facts reported are: the great majority of institutions employ such teaching help; the pay ranges from sixty cents to three dollars per hour; their teaching is without exception with undergraduates with twelve hours per week as the maximum time given.

The report is summarized by: "The consensus of opinion is unequivocally to the effect that the principle of employing graduate students in certain teaching capacities is fundamentally sound, and that when *rightly administered* it is, to state it conservatively, not in any sense to the detriment of the department employing the students, to the students themselves, or to the undergraduates." B. C. H.

Sectioning on Basis of Ability. C. E. SEASHORE AND E. H. WILKINS. *Bull. Am. Assoc. Univ. Profs.*, **12**, 133–91 (1926).—This is the report of Committee of the American Association of University Professors. Part one is largely a reprint of letters received by Dean Wilkins from instructors who have tried or are trying the plan in their courses. Of these letters quotations from six teachers of college chemistry are printed. These include teachers in the University of California, Colorado Agricultural College, University of Georgia, University of Pittsburgh, Vassar College, and Yale.

The second part of the report is headed, "Constructive Comments on Present Practices." In this Doctor Seashore discusses, in a helpful way, such difficulties as "Schedule Conflicts," "Basis of Classification," "Shifting between Sections," "Content for Different Levels," "Examinations," "Sequences," "Number and Size of Sections," "Lectures," "Laboratory," "Project Work," "Adjusting the Staff to Different Teaching Levels," and "The Loafer."

It is claimed that about one-half of the best institutions practise sectioning on the basis of ability in some form. B. C. H.

The Scientific Method and Authority. EDWIN LINTON. *Science*, **63**, 171–8, 195–201 (1926).—The line of cleavage between the desire to know and the will to believe does not now, if it ever did, run between science and religion. It "separates those who arrive at truth by way of the scientific method from those who frame their beliefs in accordance with some traditional authority."

The scientific method is defined as "those processes which every normal individual employs whereby, through observation, experimental tests, and comparison with knowledge already possessed, he arrives at a reasoned conclusion."

Authority is used in two quite different ways. When used to indicate an experienced and expert workman in a particular field care must be exercized that the choice be made by those qualified to judge. Such authority is admittedly not infallible. When used in the sense of traditional authority, misunderstanding may arise because of popular confusion with the ideas of infallibility and inspiration. "Authority even if it be of the traditional kind is not necessarily erroneous and with authority which is true, science can never come in conflict. It cannot be stated too emphatically, however, that for an authority which is not ready and willing to re-examine its foundations in the light of advancing knowledge, science can have but little regard."

Modern anti-science, pseudo science, anti-science legislation, and modern distrust of science are discussed. The author does not think the rising tide of ignorance manifested in reactionary legislation portends another dark age for civilization. He points out that informed theologians and scientific leaders manifest for each other now a respect and understanding quite in contrast to the attitude of fifty years ago. G. H. W.

We cannot command veracity at will; the power of seeing and reporting truly is a form of health that has to be delicately guarded. The penalty of untruth is untruth.—GEORGE ELIOT

Local Activities and Opportunities

Princeton. Dr. Hugh Stott Taylor, professor of physical chemistry, made a trip through the Middle West, from March 17–25, and lectured on "Catalysis and Mechanism of Chemical Reactions," before the following sections of the American Chemical Society: Pittsburgh, Akron, Purdue (Lafayette, Ind.), Urbana, St. Louis, and West Virginia (Morgantown).

Dr. Taylor lectured before the Lehigh Valley Section at Easton, Pa., on April 16th, and at the Chemical Equipment Exposition, Cleveland, on May 11th.

Dr. A. L. Marshall, instructor in physical chemistry, has accepted a position in the Research Department of the General Electric Company, at Schenectady, N. Y. He severs his connection with Princeton at the end of the present academic year.

The following Fellows in chemistry have been appointed for the academic year 1926–1927: John R. Bates, A.B., Amherst College, 1924, and H. N. Alyea, B.S., Princeton University, 1925, Procter Fellows; S. O. Morgan, B.S., Union College, 1922, DuPont Fellow; E. E. Fleck, A.B., University of Nebraska, 1924, Harvard Fellow.

On March 25th, Dr. F. G. Cottrell, Chairman of the Fixed Nitrogen Research Laboratory at Washington, lectured before the Chemical Club. Dr. Cottrell estimated that approximately 44 per cent of the world's inorganic supply of nitrogen would be obtained this year by atmospheric fixation, against less than one-fourth that amount before the war.

University of Minnesota. The school of chemistry will offer a comprehensive series of courses for the summer session this year. General and advanced courses, including research, will be offered in inorganic, organic, and physical chemistry, as well as qualitative and quantitative analysis, technology, and chemical engineering. It is thought that many teachers of chemistry will avail themselves of an opportunity to do advanced work for higher degrees.

The faculty of the school of chemistry recently voted to take advantage of the "four quarter" year. It is believed that the plan will prove more economical than the present three-quarter plan as well as make it possible for the faculty to do work at other universities.

The members of the chemistry staff and students were fortunate in being able to hear Dr. W. K. Lewis of Massachusetts Institute of Technology discuss the "Amorphous State of Matter," and Dr. S. C. Lind, of the U. S. Bureau of Mines, on the "Chemical Action of Gaseous Ions Produced by Alpha Particles." These lectures were given under the auspices of the school of chemistry.

Mr. R. E. Kirk, assistant professor of inorganic chemistry, has been granted a sabbatical furlough for next year, 1926–27. Mr. Kirk plans to spend the year in graduate study at Cornell University.

Brown University. A chemistry club has recently been formed at Brown University by the students majoring in chemistry. The club has at present approximately thirty members consisting of the sophomore, junior, and senior students as well as graduate students. The members of the faculty of the department of chemistry are honorary members. The purpose of the club is to unite the students and faculty and to promote their interest in the problems of chemistry. Two officers, a president and a secretary-treasurer, and an executive committee of five members carry out the program and policies of the club. For the year 1925–26, F. L. Kilbourne, Jr., has been made president. Owing to the increased interest in chemistry at the university the chemistry club

will undoubtedly assume a very significant part in the development of the science.

Dr. Charles A. Kraus, director of the Research Laboratories at Brown University, has completed an extensive lecture tour throughout the country, lecturing at several universities and local sections of the American Chemical Society. His lectures were primarily concerned with the research work that is being carried out at Brown University on the development of the fields of metallo-organic compounds and properties of non-aqueous solutions.

Western Reserve University. Professor E. C. Franklin of Stanford University, California, has accepted the invitation of the Senior Teachers' College of Cleveland School of Education to deliver a course of thirty lectures on "The Ammonia System of Compounds" in the forthcoming summer session. It is regrettable that teachers in the east have previously had no opportunity to learn at first hand of the ammonia system. Since Prof. Franklin expects to retire shortly the present course is uniquely attractive. Prof. Franklin's lectures and demonstrations are in themselves an education in pedagogy.

University of Michigan. The sixty-first annual meeting of the Michigan Schoolmasters' Club was held at Ann Arbor, April 1st–3rd. The program included general and divisional sessions. The former occupied mornings and evenings. They consisted of lectures, conferences, and social gatherings. Thursday morning, for example, there was a "College Entrance Requirements Conference;" Friday morning Professor Bliss Perry of Harvard spoke on "Types of Teachers I Have Known." The same evening President Little of the University discussed "Frankness in Education."

The afternoon hours were given over to assemblies restricted to special teaching fields. In all there were about twenty-five of these divisional groups. The program of the Chemistry-Physics Conference follows:

Thursday, April 1st

Chairman—Wm. McCracken, Western State Normal School.

Vice Chairman—Burton E. Smith, Grand Rapids Junior College.

Secretary—M. H. Buell, Ann Arbor High School.

1. The Electron Theory in High-School Physics, Harry Smith, Michigan State Normal College.
2. The Electron Theory in High-School Chemistry, Grayson Newark, Jackson.
3. Interchanges of Energy between Atoms and X-Ray Radiation, George A. Lindsay, University of Michigan.
4. Business Meeting.
5. Inspection Trip through the New Automatic Switching Exchange of the Michigan Bell Telephone Co.

Friday, April 2nd

12:45 o'clock

Chemistry-Physics Luncheon at the Ann Arbor High School

1:30 o'clock

6. "Does Michigan High-School Chemistry Prepare for Eastern Colleges?" Floyd A. Barber, Grand Rapids Central High School.
7. "Miller and the Michelson-Morley Experiment," John W. Hornbeck, Kalamazoo College.
8. "The Glow of Phosphorus," J. H. Hodges, University of Michigan.
9. Experiments and Lecture Demonstration.

Columbia University. The feature among the chemical courses to be offered at the summer session of 1926 will be the special lectures on Contemporary Developments in Chemistry. The appended list of titles and lectures indicates the unusual nature and extent of the course.

"Synthetic Organic Chemistry," July 6th, Marston Taylor Bogert.

"Chemical Reactivity," July 7th, James F. Norris.

"Chemical Relationships of Sugars, Optically Active Amino Acids, Hydroxy Acids, and Halogen Acids," July 8th, Phoebus A. Levene.

"Reversible Oxidation-Reduction Reactions in Organic Systems," July 9th, William Mansfield Clark.

"Crystal Structure in Its Relation to Chemical Problems," July 10th, Ralph W. G. Wyckoff.

"Structure of Atoms and Molecules," July 12th, Irving Langmuir.

"Catalysis and the Mechanism of Chemical Reactions, "July 13th, Hugh Stott Taylor.

"The Carbohydrates," July 14th–15th, Sir James Colquhoun Irvine.

"Oxidative Catalysis in the Body," July 16th, Edward C. Kendall.

"Chemistry of Immunity," July 19th, H. Gideon Wells.

"Rare Gases," July 20th, Robert B. Moore.

"Synthetic Organic Chemistry," July 21st, E. Emmet Reid.

"Permeability and Electric Phenomena in Membranes," July 22nd, Leonor Michaelis.

"Radicals as Chemical Individuals," July 23rd, Charles A. Kraus.

"The Influence of Pressure on Chemical Phenomena," July 26th–27th, Ernest Cohen.

"Chemistry of Sanitation," July 28th, John Arthur Wilson.

"Osmotic Pressure," July 29th, J. C. W. Frazer.

"Chemistry of Proteins and Bacteria," July 30th, Treat B. Johnson.

"Contact Catalysis," August 2nd, Wilder D. Bancroft.

"Present Status of the Knowledge of Water-Soluble Vitamins," August 3rd, Elmer V. McCollum.

"Ultra-Violet Light in Relation to Nutrition," August 4th, Harry Steenbock.

"Theory of Chemical Reaction Velocity," August 5th–6th, J. N. Brönsted.

"Physico-Chemical Principles in Electro-Chemical Research," August 9th, Colin G. Fink.

"Reactions in Liquid Ammonia," August 10th, E. C. Franklin.

"Agricultural Chemistry," August 11th, Charles A. Browne.

"Theory of Electrolytes," August 12th, Peter Debye.

Nebraska. The Nebraska Academy of Science met in Bethany, at Cotner College, April 29th, 30th, and May 1st. Its president, Professor Joseph Mass, is chairman of Cotner College's department of chemistry. The chairman of the chemistry section for 1926 is Professor Henry Wing of Doane College. Doctor B. S. Hopkins of the University of Illinois addressed one of the general meetings upon "Illinium, the New Member of the Rare Earth Group."

Members of the University of Nebraska Chemistry Staff who attended the A. C. S. Meeting at Tulsa were: Doctors F. W. Upson, B. Clifford Hendricks, T. J. Thompson, C. M. Knudson, and Mr. Edgar Boschult.

Doctor H. G. Deming has completed work upon the revision of Deming and Arenson's Laboratory Exercises in General Chemistry. This new edition of the book is to be published immediately.

New York University. Professor James Kendall, of the department of chemistry of Columbia University, has accepted an offer from New York University to assume the position of administrative head of the department of chemistry in the Washington Square College of the University. The introduction of courses in chemistry in Washington Square College was made only during the last few years, but under the direction of Professor W. C. MacTavish the department has shown such rapid and phenomenal growth that reorganization and extension, both of the laboratories and of the teaching staff, have been almost annual necessities. It is now planned to amplify the undergraduate courses in chemistry at present given at Washington Square College. The courses offered, in conjunction with the graduate courses at University Heights, will accommodate not only college and pre-professional students, but also more advanced workers in the science, such as students for the degree of B.S. and A.M. in chemistry and research workers for the

degree of Ph.D., as well as students in the School of Education.

Professor Kendall will be accompanied to his new post by Dr. Eric R. Jette, of Columbia, who will assist in the further development of undergraduate instruction and of graduate research, with the rank of assistant professor. Dr. William West, of Edinburgh University, who has been research assistant to Professor Kendall during the past year, will also make the transfer to Washington Square College, where he will hold the rank of instructor. Professor MacTavish will continue in his position as Director of the Chemical Laboratories.

University of Pittsburgh. Alexander Silverman, head of the department of chemistry, University of Pittsburgh, delivered an illustrated lecture entitled, "Glass: One of Man's Blessings," before the Pennsylvania Academy of Science, Harrisburg, Pa., on Friday evening, April 2nd, at the Beach Front Hotel, following the annual banquet of the Academy.

Carnegie Institute of Technology. Eight research fellowships will be available in connection with the program for next year. The fellowships are open to the graduates of colleges, universities, and technical schools who are properly qualified to undertake research investigations, and will be awarded for a ten months' period beginning August 16, 1926.

Most of the research work will be conducted in the laboratories of the Pittsburgh Station of the U. S. Bureau of Mines, adjacent to the campus. The subjects for investigation, as in the past, will be selected by two advisory boards composed of metallurgists, mining engineers, chemists, and coal operators. At the end of the period of study, the results of the investigations, it is announced, will be published jointly by the Carnegie Institute of Technology, the Bureau of Mines, and the Advisory Boards.

Among the subjects suggested for study in the announcement are the following listed under "Mining and Utilization of Fuels:"

1. Origin and Constitution of Coal: The determination and separation of coking constituents of coal; comparison of methods of determining the oil and tar yields of coal; the composition of low-temperature tar.

2. Coal Mining: Study of friction losses in mine cars; determination of cost and efficiency of storage battery locomotive haulage in comparison with trolley locomotive haulage; study of efficiency and suitability of mechanical devices in coal mining; study of methods in blasting coal; study of methods for detecting loose roofs in coal mines; study of efficiency of gunite and other protective coverings for the prevention of roof disintegration.

3. Utilization of Coal: Correlation of fusing temperature of coal ash with clinker formation in furnaces; study of reactivity of various cokes in air, carbon dioxide, and steam; study of physical properties of coke in relation to domestic heating; drop of pressure in fluids flowing through aggregates; determination of the temperature-solubility relationship between gasoline and methanol and the influence of mutual solvents; a study of catalysts for the production of methanol from water gas and hydrogen; effect of gaseous atmosphere on yields and composition of gas, tar, and coke in the low-temperature carbonization of coal.

4. Mine Safety: Study of methods of determining the degree of dustiness of mine air; study of relation of fineness of particles to inflammability of coal dust; survey of relative tendency of various coals to fire spontaneously; study of effect of fineness and nature of materials on its efficiency for rock dusting coal mines; study of effect of pressure and temperature on products of combustion of mining explosives; determination of the freezing-point curves of nitroglycerin and the depressants proposed for use in low-freezing dynamites; study of inflammability of methane and air mixtures.

Under "Ferrous Metallurgy," subjects suggested for study are the following:

1. Physical Chemistry of Steel Making: Study of abnormality of case-carburized steels; nature and estimation of

non-metallic inclusions in steel; determination of solubility of iron oxide in iron.

2. Production of Special Steels and Alloys: Metals for mill balls; metals for recuperators; recovery of alloy steel scrap; a study of the cause of differences in the physical characteristics of electric furnace and cupola gray iron; corrosion-resisting alloys for mine water or oil-well waters.

3. Metallurgical Refractories: Effect of open-hearth dusts on refractories; effect of insulation on the life of open-hearth refractories; effect of service conditions on physical properties of open-hearth refractories; requirements of electric furnace refractories.

Each fellowship carries a stipend of $750. Holders will be registered as graduate students and as candidates for the degree of Master of Science, unless an equivalent degree has previously been earned. Applications should be made to the Secretary, Mining and Metallurgical Advisory Boards, Carnegie Institute of Technology, Pittsburgh, Pa.

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As a result of the demand that has been developing during the past few years, courses for teachers are receiving special attention in the plans for the Summer Session this year at the Carnegie Institute. By broadening the variety of work offered to teachers and supervisors of public-school music, art, and manual and industrial arts, and by developing the range of technical work in other branches of the institution, the effort has been to make the service of interest to nearly every teacher who feels a need for more technical training.

The course for teachers will be given for six weeks from June 28th to August 6th. Courses for undergraduates will extend eight weeks from June 14th to August 6th. The program for both groups of courses will include work in the College of Engineering, College of Industries, College of Fine Arts, and the Division of General Studies.

As in the past few years, it is also announced, special attention will be given this summer at Carnegie to the entertainment of the students. Dances, picnics, boat rides, inspection trips, popular lectures, musical entertainment, and swimming in the pool of the new gymnasium, will constitute the main features of the social activities during the work of the session.

State University of Montana. C. W. Beaman, of the present graduating class has accepted a position with the B. F. Goodrich Co. at Akron, Ohio.

Dr. J. W. Howard recently gave a talk from the University Broadcasting Station KUOM on "The Alcohol Problem." He also gave a talk before the local Kiwanis Club reviewing in popular form some of the recent accomplishments of chemistry.

Aside from the famous Anaconda Reduction Works, Montana has a very limited number of chemical plants or manufacturing plants where the processes are essentially chemical. Hence we are much interested in the recent word from the Montana Products Company of Eureka, Montana, that they are expanding their plant for the manufacture of mucic acid and other products from the Larch.

Dr. W. G. Bateman gave a talk before the local Rotary Club on April 7th on the topic "Exploiting Health Interest."

W. E. Caldwell who has been graduate assistant in the chemistry department for the past year has accepted a similar position at the University of Wisconsin for the year 1926–27.

Georgetown University. Rev. G. L. Coyle, S. J., the head of the chemistry department of Georgetown University delivered on the evening of February 10th a very interesting lecture before the members of the Maryland Academy of Sciences at Baltimore. The title of the discourse was "The Story of Petroleum." The lecture was followed by illustrations of practical interest, depicting scenes in the oil fields and plants.

Fr. Coyle was called upon to repeat his descriptive lecture on Feb. 21st, before the members of the Fortnightly Forum of Philadelphia.

On March 2nd, Fr. Coyle delivered another interesting lecture on "Chemistry in Daily Life" before the students of the Academy of Notre Dame, Rittenhouse Square, Philadelphia.

Mr. James H. C. Loughrey, professor of quantitative analysis, has started research work on the preparation of derivatives of adrenalin with the hope that some compound may be prepared which will have to a greater degree the physiological properties already possessed by that compound.

Mr. Arthur A. Espenscheid, instructor in inorganic chemistry and organic chemistry is determining the efficiency of the various group, separating, and identification reagents used in Father Coyle's Acid Analysis Laboratory Manual.

Oberlin College. Dr. Harry N. Holmes, now on his sabbatical leave of absence, has visited universities and art museums in Amsterdam, Utrecht, Delft, Linden, Frankfort, Haarlem, Cologne, Munich, Vienna, Prague, Dresden, Leipzic, and Berlin and travelled through Switzerland. He has lectured at the universities of Amsterdam, Utrecht, Delft, Linden, and at the Kaiser Wilhelm Institute (Haber's laboratory) and met many great chemists. Among the museums he has visited is the famous scientific "Deutscher Museum" at Munich.

Cornell University. Last year a number of industrial chemists took advantage of the opportunity presented by the summer courses at Cornell to become familiar with the methods of Chemical Microscopy, and the department of chemistry will offer similar work during the coming summer session. The equipment of the new Baker Laboratory is unique in this field and affords excellent facilities for the study of the various applications of the microscope, to chemical problems.

The elementary course will cover the use of the microscope and its accessories, micrometry, quantitative methods, study of crystals, handling small amounts of material, methods of illumination, determination of index of refraction, examination of textile and paper fibers. A course in microscopic qualitative analysis including the reactions of the more common acids and metals will also be given; both of these will be the full equivalent of the courses given during the regular college year. Either one or both of these courses may be taken or other work in the department may be carried on, according to the needs of the student. The Summer Session opens July 5th, and continues for six weeks, but persons not desiring university credit may arrange to cover, in a shorter period, those portions of the course most suited to their special line of work.

Any inquiries regarding the above courses should be addressed to Dr. C. W. Mason, who will have charge of the work.

University of Florida. Dr. Townes R. Leigh, head of the department of chemistry, has just returned from the Tulsa Meeting of the A. C. S. He reports a most enjoyable session. He will address the next meeting of the Florida section on the high points and accomplishments of the spring meeting.

Mr. Ralph P. Perkins, B.S., Ch.E., Florida, 1923, has been designated a graduate assistant in chemistry at Northwestern for the year 1926–27. Mr. Perkins has been doing graduate work in chemistry at Pennsylvania State College during the past year and immediately following his graduation was chemist for the Florida Cotton Oil Company.

The *Pharmaceutical Journal and Pharmacist* (English), for February, carries an interesting article on pharmaceutical education in Florida. The School of Pharmacy was founded three years ago, with Dr. Townes R. Leigh, head of the chemistry department, as its head. In 1924 its very rapid growth brought about its organization as a College of Pharmacy with Dr. Leigh as Dean. Dean Leigh, Ph.D. (Chicago) and F.S.S. (London) directs a professional staff, every member of which holds the doctor's degree in addition to various professional degrees. Plans are practically completed for the new chemistry-pharmacy building which

will house both the department of chemistry and the College of Pharmacy.

Kentucky. The spring meeting of the Kentucky Association of Chemistry Teachers was held at Louisville, April 22nd. The program consisted of a welcome by President Ford; an address on "New Alloys and Rust Proofing of Metals" by Dr. C. H. Humphries; a Round Table Discussion on Note-books by Dr. A. W. Homberger, Mr. R. L. Brown, and Mr. O. B. Ellis; and a report of the Tulsa Meeting by Dr. R. N. Maxson. This was followed by a business meeting at which Miss Marie Borries, Girls' High School, Louisville, was elected president and J. C. Branham, Massie School, Versailles, was elected secretary. The afternoon session consisted of inspection trips to Van Camp's Cottonseed Products Co. and the Kentucky Oxy-Hydrogen Co.

Colloidal Lead Joins X-Rays and Surgery to Relieve Cancer. With thirty almost hopeless cancer cases apparently cured Prof. Blair Bell's lead treatment comes well to the front, if not to the center, of the crowded arena of cancer research.

Of the 227 practically hopeless cases treated since November, 1920, 30 have been pronounced cured, in ten the cancerous growth has been arrested, and nine are considered greatly improved. Dr. J. G. Adami, vice-chancellor of the University of Liverpool in a comment in the English medical journal, *Lancet*, in which Prof. Bell's papers on the lead process of treating cancer have appeared, says that the thirty cured patients show no sign of lead poisoning or recurrent cancer, are in good bodily condition, and are following their usual occupations.

The funds to carry on this line of cancer research have been furnished by private endowment and are administered by the Liverpool Cancer Research Committee of which Prof. Bell is now director. Prof. Bell has been assisted in his work by the department of physical chemistry of the University of Liverpool.

Lead salts injected directly into the circulatory system are poisonous. Colloidal lead, with which the best results are obtained, consists of small particles of lead suspended in a state of more or less unstable equilibrium. The problem of the chemistry department of Liverpool, then, has been to devise a method by which a lead colloid could be made more stable and effective. A group of scientists working under Prof. W. C. McC. Lewis have been conducting a series of investigations but have not yet been able to make a preparation that will stay suitable for use for more than a few days.

As yet, according to the account in *Lancet*, the product is still so unstable and difficult to prepare as not to warrant the publication of the procedure necessary to make it. It is hoped that ultimately a permanent colloid will be perfected which will be then made available for use in the hands of clinicians carefully trained to administer it.

In his most recently published analysis of his results Prof. Bell stresses the point that much work must still be done to make a more active preparation of lead that will be less poisonous to the system generally. All types of malignant growths, he declares, are probably amenable to the beneficial influence of lead if only enough of the metal can reach them.

He does not hesitate to employ auxiliary measures of surgery, X-rays, or radium when circumstances seem to warrant, but recommends that when the growth has been partly or apparently entirely removed "intravenous injections of lead should be employed within a few days of the operation when possible."

In conclusion he states that "the method of treatment is difficult, and to some extent dangerous and can only be safely employed by those who are thoroughly experienced in the work, and have laboratory facilities at their disposal."—*Science Service*

Recent Books

Chemistry and Recent Progress in Medicine. JULIUS STIEGLITZ. The Williams & Wilkins Company, Baltimore, Maryland, 1926. viii + 62 pp. 22.3 × 15.2 cm. Cloth $1.50. Paper $.75.

This volume comprises the second series of The Charles E. Dohme Memorial Lectures on the Relation of Chemistry to the Progress of Medicine at The Johns Hopkins University.

The author states in the first paragraph that "a lifelong interest in the great possibilities of chemistry in the service of medicine" prompted his acceptance of the invitation to deliver these lectures. The book shows the applications to the problems of medicine, of advances in the realm of chemistry, and pleads for greater coöperation between the two sciences. It outlines two broad fields in which chemistry contributes to medicine; one dealing with materials having to do with the care and prevention of disease, the other with functional or dynamic side of chemical action. It treats: specific drugs; active principles of the glands; the vitamins; antitoxins and vaccines; oxidation; fundamental electronic processes.

The lectures are of a very high order. Seldom has the reviewer seen so much fundamental material so admirably presented in the compass of hardly more than an hour's reading. This book is a distinct contribution to the literature of scientific medicine and should be in the hands of the members of the profession and might well be required as collateral reading for senior medical students.

WORTLEY F. RUDD

Outlines of Qualitative Chemical Analysis. FRANK AUSTIN GOOCH, Ph.D. and PHILIP EMBURY BROWNING, Ph.D., Assistant Professor of Chemistry in Yale University. Fifth edition, revised, with appendix. John Wiley and Sons, Inc., New York, 1925. viii + 206 pages. One colored section chart. 13.2 × 20.3 cm. $1.75 net.

As stated in the preface, the authors have prepared this text to meet the needs of large classes in qualitative analysis, of those preparing for work in related scientific fields, and of the specialist in exact analysis. The authors have chosen a happy medium which such a manifold purpose necessarily requires, namely, of arranging much of the matter-of-fact material in tabular form for ready reference. In so doing, however, they have placed less emphasis upon the important principles underlying qualitative analysis, disposing of the theory briefly in about twelve pages of text, and rather stressing experimental details.

The reviewer is inclined to question the value of tabulating the characteristic reactions of the ions, chiefly because they do not compel the student to reason things out for himself. Such a scheme, moreover, is likely to leave the impression with the student that each salt or ion is a law unto itself; it would seem preferable to stress such classifications of facts as the electromotive force series, the solubility table, and the periodic system, and to teach the student to reason out each case by a process of elimination. The charts, however, do possess much valuable information, and if included as an appendix would be helpful, especially to the commercial analyst.

The "experimental reviews of important reactions" include many of the ordinary reactions with which the student is already familiar. The experience of the reviewer has been that such preliminary experiments are time-consuming, and detract greatly from the interest of the subject. It seems desirable to start the student immediately on a group separation where he will in due time become acquainted with the reactions of each ion. The review questions at the end of the book are chiefly memory questions. Very few balanced equations have been given; the authors have wisely left them for the student to work out himself or to find in reference books. The chapter on organic analysis, including acids, alcohols, carbohydrates, and alkaloids, appears out of place in a work of this kind. Few students taking qualitative analysis have had organic chemistry, and the time is generally so short that one scarcely succeeds in covering the inorganic acid radicals thoroughly. They might be included to advantage in a reference work on organic analysis.

Some inconsistencies appear in the writing of formulas. Where ions or radicals are referred to, as on pp. 14–15, rather than the specific element tested for, they should be written with their respective positive or negative charges. The obsolete empirical formula appears to be preferred by the authors over the ionic; on page 50, both forms, FeO_2H_2 and $Fe(OH)_2$ are employed! To write ferrous ferricyanide, $Fe_3Fe_2C_{12}N_{12}$, would seem to complicate needlessly the writing of formulas for the student, who sees in this formula no relation between the valences of the radicals composing the compound. On page 160, a "double salt of $xAgCl.yNH_3$" is referred to, but this compound does not in any sense conform to the accepted definition of a double salt.

The book is strikingly free from typographical errors and exhibits much careful and painstaking work. Its clarity of presentation, and discrimination in the choice of tests to make the identification of elements more positive and certain, are features which speak decidedly in its favor.

T. F. BUEHRER

A Treatise on Physical Chemistry. Edited by HUGH S. TAYLOR, D.Sc. (Liverpool), Professor of Physical Chemistry, Princeton University, Princeton, New Jersey. D. Van Nostrand Company, New York, 1925. Vol I, xi + 644 pp. Illustrated. Vol. II, ix + 700 pp. Illustrated. 23 × 15 cm. Price $12.00.

The aims of these books are stated by the Editor in the preface: "The present treatise on physical chemistry represents, therefore, a co-operative effort on the part of a number of physical chemists to cover generally the major portions of their science by contributions in those portions of the subject which their particular inclinations have led them more especially to study and to which they themselves may have contributed by their own effort and research. It is hoped that, in this way, a more authoritative treatment of the several branches of the subject may have been achieved; perhaps, also, a fresher exposition of the subject in its various phases may have been realized." That these aims have actually been realized, would undoubtedly be admitted by even the most exacting critic. Most of the chapters of the treatise contain a wealth of information, and are full of suggestions for the seeker of the truth. We fully agree with the editor that the divergent opinions in regard to some concepts, held by different writers of the chapters, while confusing to the beginner, are yet stimulating to the advanced student in designating the avenues of research still open and the necessity of more fundamental concepts.

Beside the authoritative treatment of most of the chapters, the treatise has a tremendous lure in that it presents the subject of physical chemistry as a growing science. This fact is primarily accounted for on the basis that the subject-matter has been presented by investigators actually working in the fields of which they wrote. One can almost feel the enthusiasm of the writers—some of them become so enthused that they just "bubble over." The book is inspiring from that standpoint.

The treatise certainly is an improvement over other books where the writer merely decided to write a book, not because he had any new concepts to contribute, but merely to see his name in print. These "compilations" are dreadful bores, for a great deal of the time the writer does not have first-hand information of the subjects he is presenting and the book, therefore, has not any stimulating effect.

Undoubtedly the treatise is not of uniform excellence. That, however, is traceable to the causes indicated above. It is also unkind to judge books by the errors in printing, etc. It is the "spirit of the book" that should concern a reviewer, and in that respect the book is a decided relief from others that have flooded the market. Personally, the reviewer would be satisfied, if he had to make such a choice, to give up all the works in physical chemistry he has in his possession if he could retain this treatise.

M. S. KHARASCH

Makers of Modern Chemistry. SIR PRAFULLA CHANDRA RÂY. Chuckervertty, Chatterjee and Co., Ltd., Calcutta; Probsthain and Co., London. First edition, 1925. viii + 110 pp. 13 full page pictures, including 7 eminent chemists. 14 × 21½ cm.

This book contains six historical lectures; also "The Story of the Discovery of Oxygen." The first five lectures were given, by invitation, in the University of Dacca, in which the author is professor of chemistry.

Lecture I deals with the phlogiston theory and with the work of Jean Rey and John Mayow. In the words of Mayow, who died in 1679, "Combustion is due to that portion in the air which occurs in saltpeter, which is also helpful for respiration."

Lectures II and III deal largely with the work of Priestley, Scheele, Liebig, and Davy.

Lecture IV is devoted to Davy's work on the elementary nature of chlorine, to Paracelsus, Boyle, Berthollet, Gay-Lussac, Berzelius, Liebig, and others.

Lecture V is devoted to John Dalton and his contributions to chemistry.

Lecture VI deals with India's gifts to the world. Attention is called to the non-corrosive quality of the metal in the iron pillar near Delhi. This pillar of pure iron is unrusted after exposure to the elements for about fifteen centuries. It is also shown that the Hindus knew the difference between sodium carbonate and potassium carbonate 2000 years before the remarkable discoveries of Joseph Black. Indeed, they knew how to prepare caustic potash by treating slaked lime with potassium carbonate. "This method, you will look for in vain in any European treatise before the 16th or the 17th century."

Dr. Rây is an authority on matters pertaining to the Indians of the past, having written a two-volume work entitled "A History of Hindu Chemistry."

The "Makers of Modern Chemistry" is beautifully and entertainingly written, and deserves a place in the library of all who are interested in the history and development of the science of chemistry. It is very valuable to get the viewpoint of an eminent teacher and scholar who is thoroughly familiar with the past and present intellectual life of India.

WILLIAM FOSTER

TO BE REVIEWED LATER

Einfuhrung in die physikalische chemie und kolloid chemie—Kruyt.

Introduction to Theoretical Physics, Vol. II—Haas.

Physics Experiment Sheets—Nelson.

Popular Research Narratives—Engineering Foundation.

Problems in Organic Chemistry—Underwood.

PRELIMINARY PROGRAM FOR THE FOURTH NATIONAL COLLOID SYMPOSIUM, CAMBRIDGE, MASSACHUSETTS, JUNE 23, 24, 25, 1926

J. W. McBain	"A Survey of the Main Principles of Colloid Science"
W. D. Bancroft	"The Water Equilibrium"
F. E. Bartell	"The Function of Carbon Membranes in Osmosis and Ultrafiltration"
T. R. Briggs	"The De-Inking of Paper"
F. L. Browne	"The Place of Adhesion in the Gluing of Wood"
E. F. Burton	"The Helmholtz Double Layers as Related to Ions and Charged Particles"
G. L. Clark	"X-rays and Colloids"
W. P. Davey	"Making and Breaking of Emulsions"
K. H. Gustavson	"Effect of Pretreatment with Various Salts upon the Combination of Collagen with Tannin and Chromic Oxide"
E. O. Kraemer	"Studies on Gelatin"
W. K. Lewis	"Mass Action Effects in the Interaction of Gelatin and Acid"
I. F. McClendon	"Colloid Properties of the Surface of the Living Cell"
B. Mead	"Emulsification: A Study of Oil Soluble Emulsifying Agents"
S. E. Sheppard	"Deflocculation and Flocculation of Silver Halides"
Miss G. Spence	"Pectin Jellies"
A. J. Stamm	"Electroendosmose through Wooden Membranes"
H. S. Taylor	"The Colloid Particles as Revealed by Catalytic Studies"
C. Terzaghi	"The Mechanism of Adsorption and the Swelling of Gels"
A. W. Thomas	"The Adsorption of Ferric Oxide Hydrosol by Charcoal"
H. B. Weiser	"Ionic Antagonism in Colloid Systems"
G. S. Whitby	"Organophile Colloids"
H. R. Kruyt	(Not announced)

Russian Experiments Confirm Millikan's Super-X-Ray Find. The discovery of super-X-rays, consisting of extremely short-wave radiations coming to the earth from outer space, possessed of tremendously high penetrating power, has been confirmed by two Russian scientists, Dr. L. Myssowsky and Dr. L. Tuwim, who have repeated parts of the experiments performed by Dr. R. A. Millikan in the United States and by Dr. Kolhorster, the German pioneer in super-X-ray research.

The Russian scientists made tests of the penetrating power of the rays by sinking specially arranged electroscopes beneath the waters of Lake Onega in Western Russia, and found that the rays were quenched at a depth of 19 meters, or about 60 feet. This was the depth determined by Dr. Millikan in California mountain lakes, and by Dr. Kolhorster in the Bosphorus during the World War. Waves able to pass through this depth of water, plus the thickness of the earth's atmosphere through which they come on their way from outer space, have a penetrating power, according to the physicists' calculations, that would carry them through six feet of lead.—*Science Service*

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